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# BUREAU OF PUBLIC WORKS

# Quarterly Bulletin

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THE GOVERNMENT BUILDING OF THE PROVINCE OF LAGUNA.

# QUARTERLY BULLETIN

BUREAU OF PUBLIC WORKS
MANILA, P. I.

ISSUED QUARTERLY BY
THE PROVINCIAL DIVISION, UNDER THE DIRECTION OF
THE DIRECTOR OF PUBLIC WORKS

C. A. TANSILL, COMPILER


The objects of the QUARTERLY BULLETIN are:

1. To show each engineer and employee of the Bureau of Public Works the work of the Bureau as a unit.
2. To show him that his work is a unit part of the whole.
3. To make clear to every provincial and municipal official and to the people the work being done by the Bureau.
4. To make the work of the Bureau of personal interest to all.

## CONTENTS.



## WHO PAYS THE BILL?

A roof nearly new leaks like a sieve and has to be renewed or rebuilt with better materials or better design or both. Who pays the bill? A foundation gives way; a dam goes out; a ceiling falls down; a bridge fails; a roof blows off; a building collapses; a road washes out; a well strikes no water. Who pays the bill? Who, in fairness, in justice ought to pay it?

There appears to be a great deal of confusion in the minds of officials and citizens, both Americans and Filipinos, in regard to this question. Shall it be the individual engineer who designs, constructs, or inspects the work? The contractor who builds it? The Bureau of Public Works as an organization? The party who originally paid for it? Or the public at large?

As to the individual engineer it is obviously impossible to hold him financially responsible for mistakes or failures. A single error of judgment on his part may cost more than his entire salary of a lifetime. Nor is it customary in any part of the civilized world to hold a professional man financially responsible. A captain loses his ship but he does not reimburse the owner for the loss, nor does he lose his standing as a captain unless investigation shows him to have been negligent in his duties. The average lawyer must of necessity lose at least 50 per cent of his cases; but he does not reimburse his clients for their financial loss even though their cases may have been lost through his ignorance or incompetence. The doctor loses many cases; but he makes no financial reimbursement for his mistakes, though he may lose both prestige and practice if his mistakes are too frequent or too well known. Architects and engineers are required to design fireproof structures; but no one would think of holding them financially responsible for damages caused by fire.

There is a curious popular misconception that engineering is an exact science and therefore an engineer should make no mistake. Nothing could be further from the truth. As well say that because the rules for computing interest are exact the business man should make no mistakes or failures. In fact, the very engineering formulas used for computing the size of a beam, the flow of a river, or the bearing value of a pile are based on assumptions that are only approximately true and in some cases may be as much as 50 per cent in error. The results obtained by their use depend entirely on the skill, experience, and judgment of the engineer who applies them. He must select the constants to be used just as a business man must from his general knowledge decide whether a certain enterprise will pay 2 or 20 per cent on the investment. An engineer pits his training, experience, and skill against the unknown in nature. His structures must stand against flood, typhoon, earthquake, fire, and decay. In addition to these unknown quantities he must also provide against the uncertainties of imperfect workmanship, variable character of materials used, and the vagaries of foundations, as well as the use and abuse to which his structures may be subjected during their life.

In the beginning, engineers untaught by experience and unskilled in technical knowledge provided against all unknown factors by building structures five, ten, twenty, or even a hundred times as strong as they really needed to be. In those days expense was a secondary matter. In the present day, from a business point of view, a good engineer is said to be a man who can accomplish for ₱1 what any fool can do for ₱2, and the best engineer is the one who can secure the largest useful return per dollar invested. The general public should understand that it requires no engineering skill to build structures of such enormous proportions that there is no possibility of failure. It does require engineering skill, however, to so design and plan structures as to get reasonably safe and satisfactory results with the least amount of expenditure. To do this it is necessary to approach the safety line. The best engineers expect to have a certain percentage of failures. Some corporations figure on a loss of 5 per cent as indicating the greatest possible economical efficiency in design and construction.

This principle is well illustrated in the case of bridge construction in the Philippine Islands. If we were to eliminate entirely a 5 per cent probable failure of all bridges designed and built, it would result in an enormous waste of public funds through unnecessarily heavy designs, expensive foundations, and needlessly large waterway areas. As an example: With the odds of about 1 to 20 the abutments for the Cabugao, Lapog, and Bical bridges were considered reasonably secure with an expenditure of ₱8,000. We did the same thing on 30 similar bridges. We lost on the 3 bridges mentioned, but won on the 30 others. Had the abutments which were lost been made entirely secure originally it would have required an additional expenditure of approximately ₱39,000, and on the same basis the other 30 bridges similarly constructed would have needed an additional expenditure of not less than ₱300,000. The result is that we lost ₱8,000 on the construction of the Cabugao, Lapog, and Bical bridges but saved ₱300,000 on the others. In this case, in spite of three failures, the engineers and the Bureau of Public Works are in justice entitled to the highest praise for having economized public funds.

To illustrate further, since the district engineer organization was effected in 1906, approximately ₱6,000,000 has been expended for bridges and culverts. Exclusive of a few small culverts which may not have been reported, and the Benguet Road, the total loss to

date has been ₱98,950, or about 1½ per cent. It was realized some time ago that there were not enough failures to indicate the truest economy. More economical designs are now used as shown by the economy of 1913 over 1912. In 1912, 358 structures were built at an average cost of ₱2,905 per structure; total ₱1,040,000; average span 4.72 meters. In 1913, 508 structures were built at an average cost of ₱2,366 per structure, total ₱1,202,000; average span 5.20 meters.

This economy is in part due to increased efficiency of the field organization, but is chiefly due to more economical designing without sacrifice of durability or quality of materials used.

At the average cost of the preceding year per lineal meter, only 378 structures would have been built. Even if we lose 25 bridges, or 5 per cent of the total, there is still a clear gain of 105 structures as the result of a single year's operations along lines of truest economy. It takes no small degree of courage for an engineer to assume the risks necessary for true economical design and construction, knowing as he knows that the probable failures incident to such a policy are likely to bring upon him an unintelligent and unjust criticism, which in the case of a young engineer may even ruin his reputation. It is the province and policy of the Bureau of Public Works as an organization to protect its engineers from such unjust criticisms. This does not mean that incompetency, gross errors, or ignorance of correct principles will be condoned. It does mean that legitimate business risks intelligently assumed will not be held against any engineer in the service.

Right here a word of caution is needed; the financial policy herein outlined must never be applied to single structures whose failure would cause great loss of property outside of the structure itself, or whose failure would cause great danger to human life.

The question "Who pays the bill" is still to be considered. A contractor, if he does his work without fraud, cannot be held responsible for the design of the structure which he builds. In the case of fire, loss at sea, or loss of human life, it is customary for the individual to protect himself by means of some form of insurance by which a number of individuals distribute the loss between themselves through the agency of an insurance company which derives a profit from the transaction. The Bureau of Public Works is not an insurance bureau. It is organized for the purpose of expending public money for the construction of public works. If it is the desire of the public that the Bureau of Public Works be made an insurance bureau as well as a construction bureau it will be necessary to provide funds for that purpose through proper legislation. This might be done by a percentage on all construction to form an insurance fund to cover any loss, or by specific appropriations for specific cases, such as the allowance in the last appropriation bill to refund the cost of all unsuccessful wells. Unless some such legislation is enacted the Bureau of Public Works as a matter of general policy cannot be expected to pay for losses of any nature nor will it be its policy to do so.

Clarence W. Hubbell

## PROVINCIAL CENTERS IN THE PHILIPPINE ISLANDS.

By H. F. CAMERON, Member American Society of Civil Engineers,
Member Philippine Society of Engineers.

[See title-page for Laguna provincial building.]

The Government of the Philippine Islands for the purposes of efficient administration has been divided into provinces of two classes—Christian and non-Christian. Of the Christian provinces, which form a part of the civil government, there are 31, each with its provincial capital center and the necessary buildings for the provincial administration.

These provinces have a government somewhat similar to the State governments in the United States, except that there is no legislative body. The governing body—the provincial board—consists of three members—two elective (the governor and the third member) and one appointive (the provincial treasurer). The other officials that reside in the provincial center, with duties either wholly insular in character, or provincial or a combination of both, are the district engineer, district auditor, district health officer, district forester, district veterinarian, provincial fiscal, provincial assessor, provincial sheriff, superintendent of schools, weather observer, postmaster, inspector of Constabulary, and internal-revenue agent. Some of these officials by law have offices in the provincial capitol and others by permission of the provincial board. The capitol must also contain a court room with offices for the judge of the Court of First Instance for the performance of his legal duties. This room, as a rule, is used as the assembly hall for official gatherings of all purposes.

The types of provincial capitols constructed under the Spanish Government administration were in a few cases attractive both in design and surrounding, but in many cases not of durable construction.

The materials employed in their construction consisted of Philippine hardwoods, lime-pebble concrete, lime-rubble concrete, brick masonry, cut stone of either sea coral or an adobe known locally as Guadalupe or Meycauayan, and combinations of the above materials.

Under the American administration there have been constructed two Oregon pine or Douglas fir, one Philippine hardwood, and several reinforced-concrete capitols. The reconstructions of old Spanish constructed buildings have in most cases been in reinforced concrete also.

The majority of the roofs of the Spanish constructed buildings were of the heavy curved Spanish clay tiles that are made water-tight at the joints by a liberal application of lime mortar. Most of these roofs have failed in late years through deterioration of the timber framework from white ants or dry rot and the roofs replaced by corrugated galvanized iron. This same class of iron has been generally used for the buildings of the American construction until recently when the quality of the recognized brands of years ago has deteriorated so badly in the grade of the iron and quantity of spelter used that flat cement tiles are being substituted on new constructions, or a galvanized iron with a specification of 99.8 per cent pure iron and to contain not less than 2½ ounces of spelter per square foot of sheet.

Only in a few cases do the provincial centers constructed in Spanish days show any provision for future expansion or for attractive parking, and accordingly an excellent capitol may face the church or municipal plaza, white and bleak looking, where a little landscape gardening would have given a really magnificent effect.

The policy of the present administration relative to these centers, however, may best be understood from the following sketch furnished by the Consulting Architect, Mr. William E. Parsons:

Buildings of provincial governments, like those of any architectural composition, should be arranged in a logical and convenient scheme. The order and system which exists in the form of provincial government should prevail and find expression in an orderly plan for grouping buildings.

This has been the purpose of this office in designing provincial government centers. On account of practical difficulties in execution, in some cases it has not been possible to fully realize this ideal.

The scheme herewith presented for the capitol of Pangasinan at Lingayen is the largest and most complete of any yet designed.

Unlike municipal buildings and markets, provincial buildings need not be near the centers of population. In fact, a location at some distance from the business centers is much to be preferred for both practical and æsthetic reasons. This idea has been followed out in the Provinces of Iloilo, Albay, Pampanga, Tarlac, Laguna, Rizal, Nueva Ecija, Bulacan, and Tayabas and will govern in future cases.

Provincial buildings should be in a park, in a position of dignity and retirement. Here they are removed from the noise and dust of the streets and from the danger of fire spreading from neighboring buildings.

Then there is another thing which will come in due time but has hardly been successfully accomplished yet. The park which surrounds the buildings ought to have well-kept lawns with shade trees and blossoming plants which the Tropics like no other climate afford. Quite the most beautiful thing in the vicinity, it ought to set a good example in the way of beautifying the streets and plazas of the municipalities. Where there is prison labor, good soil, good drainage,

and a supply of water in the dry season, the conditions are ideal for its accomplishment.

Each province should maintain a small nursery in its provincial park for the propagation of trees and plants from seeds and cuttings. This could be done by prison labor with a little intelligent supervision. The nursery could furnish young trees for planting along not only streets and plazas, but also the provincial roads.

This expression of the Consulting Architect may define the present-day policy of the administration.

A short description of the capitols of the 31 provinces show the provinces that have made progress along the lines of this policy and those that still have room for further improvement.

### ALBAY PROVINCE.

The Albay capitol is one of the reconstruction efforts of the American administration and was completed in 1908.

The first-story walls are old Spanish masonry with concrete portico and inclosure. The first-story floor and the second-story walls are of reinforced concrete. All interior fittings are of native hardwoods.

The building has modern sanitary plumbing and a good water supply, piped from the reservoir of the military government at Camp Daraga (Regan Barracks).

The adjacent park improvements completed to date consist in grading, fencing, and beautifying of the grounds. The results accomplished are very commendable and augur well for the future.

### AMBOS CAMARINES PROVINCE.

The present capitol of Ambos Camarines is the result of a reconstruction after the old Spanish building was severely damaged by an earthquake in 1907.

The first story has walls constructed during the Spanish régime of a lime and lava masonry finished with stucco, as is also the front section of the second story. In order to hold the old masonry together a belt of reinforced concrete was built around the top of the first-story walls. The remainder of the second story, as well as the interior partitions, floors, doors, and windows, have been constructed of native hardwoods.

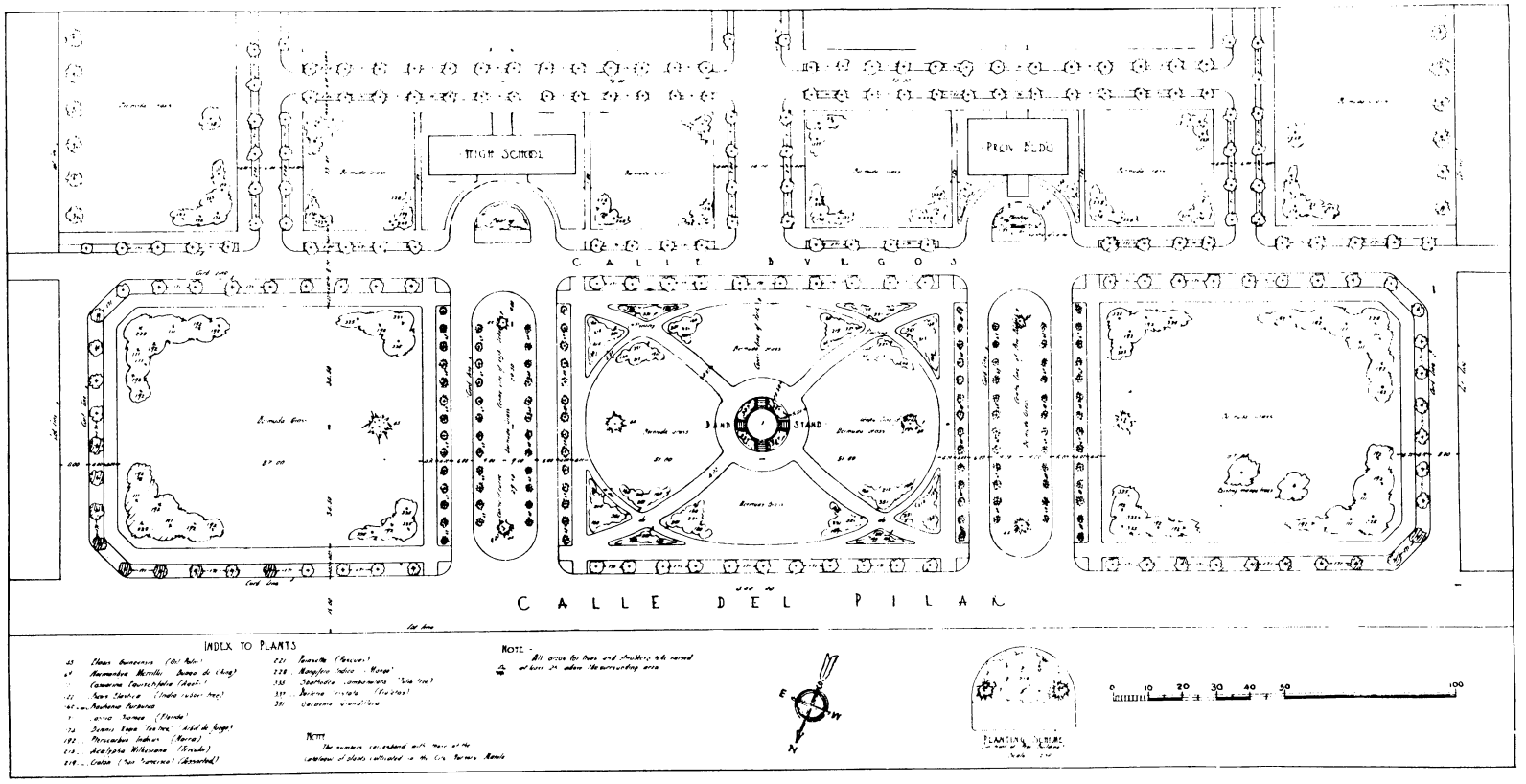
The building is well arranged, has sufficient office room, and stands on a site containing about 7,500 square meters which has been parked very attractively with good walks, lawns, shrubbery, and trees of different varieties.

The whole aspect of the capitol is very pleasing and there is no necessity at this time for expansion.

### ANTIQUE PROVINCE.

The Province of Antique does not own a provincial building or a site for one. The present building occupied belongs to the municipality of San Jose. It is constructed of adobe stone for the first story and native hardwoods for the second story.

Besides using this building for the provincial offices part of the first floor is used for the provincial jail.




Plan of development of provincial center, Cabanatuan, Nueva Ecija.

### BATAAN PROVINCE.

Probably the oldest capitol is that of Bataan on which construction started in 1792 and was finished in 1794.

The material of construction for this building was of cut adobe stone for both stories except the upper section of the facade which is of wood, probably of a later day construction. This building, especially the rear view shown, typifies the Spanish construction at the end of the seventeenth century in the Philippines. Note the massive buttresses and the wooden pin-tied roof plates shown in this view.

The first floor is paved with burnt clay bricks and cobblestones, while the second-story floor is of native hardwood.

The original tile roof has been replaced by a galvanized-iron roof.

There is not sufficient property with this building to allow for any of the modern parking now required.

BATANGAS PROVINCE.

Probably the finest looking capitol, architecturally, of the Spanish régime is that of Batangas Province.

It faces north along one side of the municipal plaza for almost its entire length. To the east, facing the end of the plaza, is a magnificent stone church which lends itself to the general scheme and gives a sense of pleasure to one entering the town from the north or west. The park itself contains a band stand, has many large well-shaped trees, and is laid out with pleasant walks.

The first story of the capitol is made of adobe masonry quarried in the immediate vicinity and the second story is of native hardwoods. Part of the roof still retains the original curved clay tiles, while in other portions this tile has been replaced by galvanized iron.

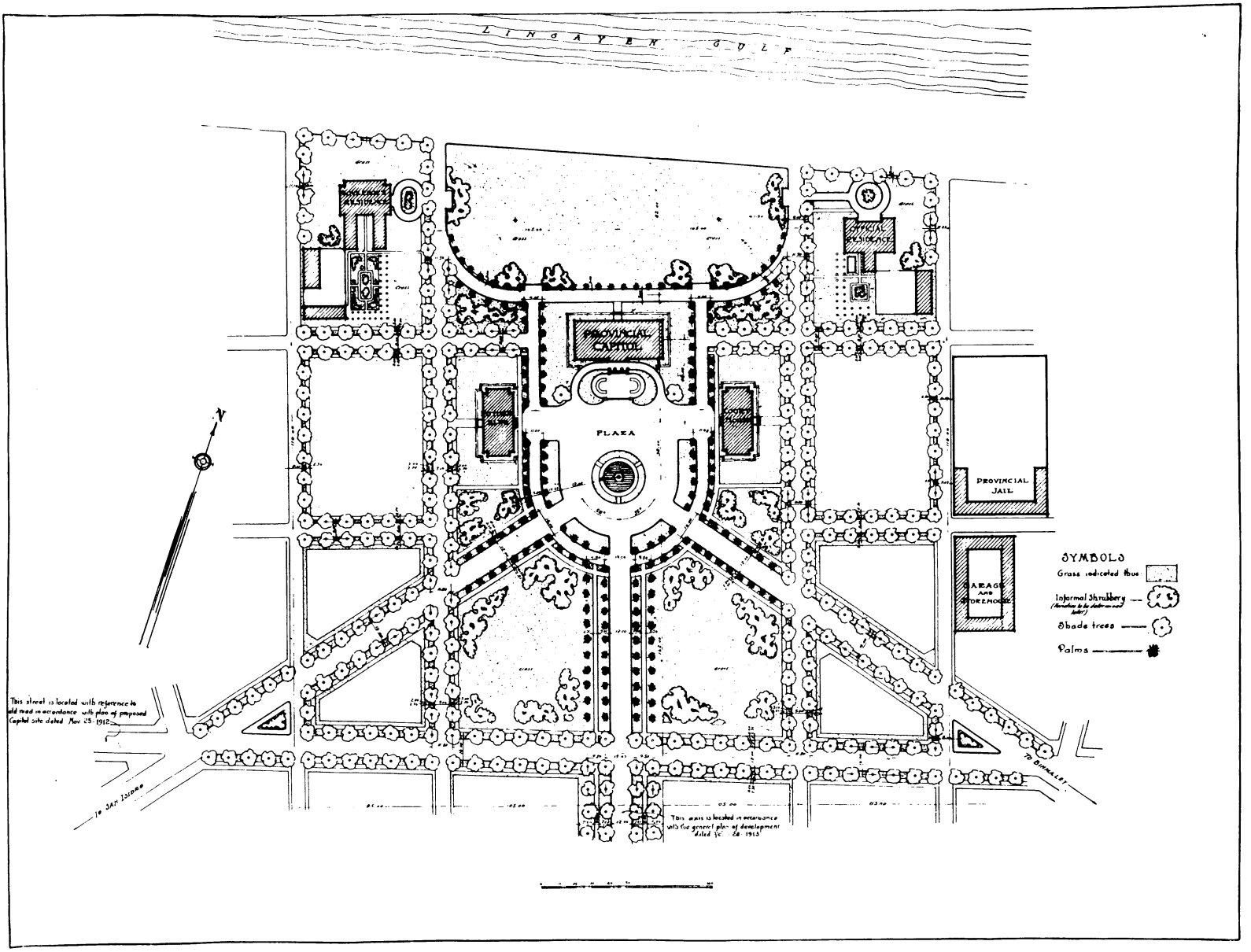
As the capitol is located in the present business center of the town there is no opportunity to carry out the present-day ideas as to beautifying, except on municipal grounds.

BOHOL PROVINCE.

The capitol of Bohol Province is a fine example of the cut sea-coral Spanish construction. This building was constructed in 1860 and the only alteration in the original structure has been the replacing of the tile roof by galvanized iron.

Though this looks like a large building it was inadequate for present-day purposes and a large addition has recently been constructed at the rear of the present building to furnish more office room.

In situation this government center was ideal for the time it was built when the people through the Visayas were always on the lookout for attacks from the Moros. Founded on a precipitious bluff overlooking the ocean approaches, the provincial building faces one side of a hollow square opposing a large and most picturesque church situated on the edge of this bluff.



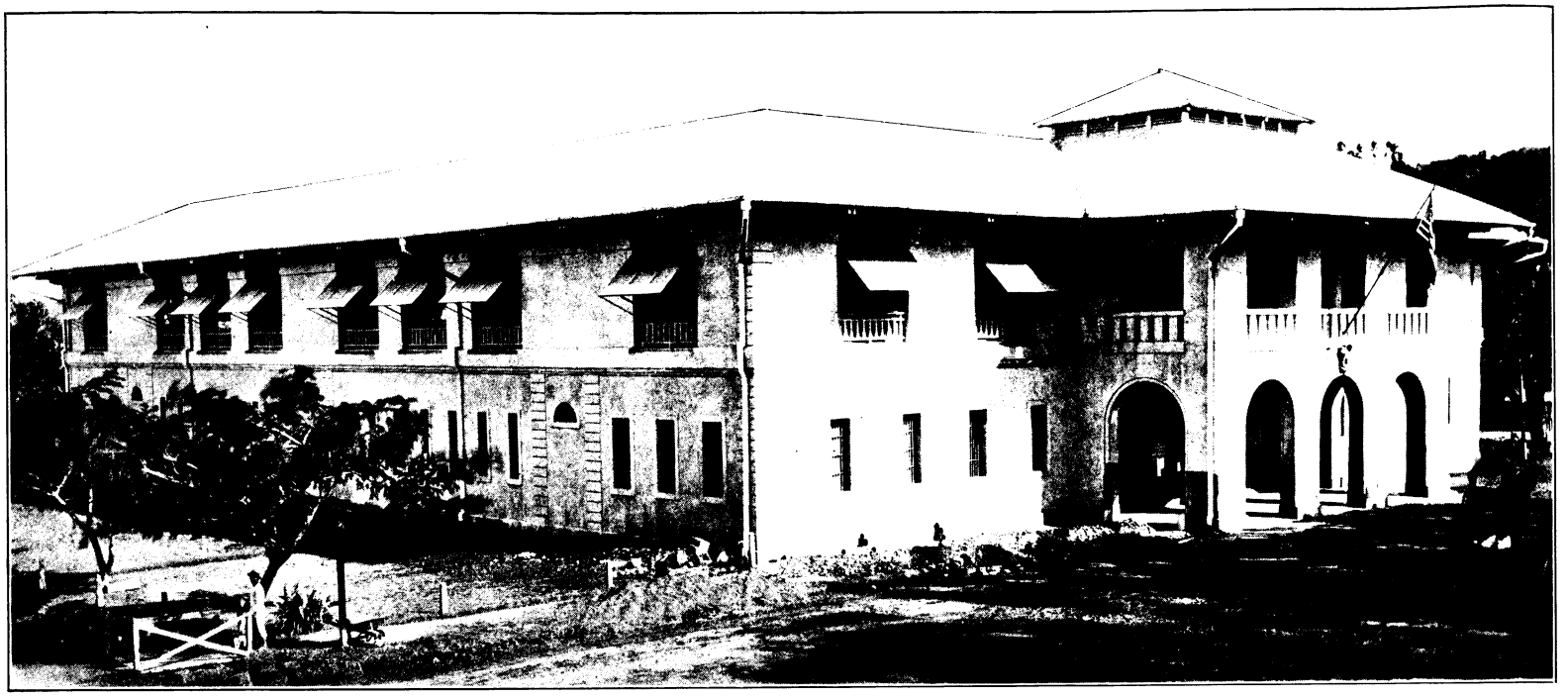

Plan of development of provincial center, Lingayen, Pangasinan.

The cut coral-stone construction in the walls is unusual, inasmuch as it is solid construction instead of acting as facings and forms for an inside lime-pebble or rubble masonry.

Its central position in the town and the smallness of the property upon which the building is located forbids parking improvements.

BULACAN PROVINCE.

In Bulacan Province the capitol was constructed of Oregon pine in 1904. It was one of the three wooden capitols constructed by the American administration and has one story only. The foundations are of adobe stone carrying a framing system of native hardwoods.



Provincial government building, Albay, Albay Province.

The government center is at a distance of 2 kilometers from the business center and contains a large area capable of expansion.

A complete street system has been laid out and constructed through these grounds, many trees have been planted that have now reached an age of 8 years, schoolhouses and residences have been erected, and altogether a rather attractive parking system has been developed.

The one bad feature, which it was impossible to avoid, was the lowness of the ground, which becomes inundated every year during the rainy season. It is reported by the district engineer that this inundation has a good feature inasmuch as the white ants cannot live in this soil and consequently the buildings have not been at all injured in this respect, a rare thing for a wooden structure in the Philippines.

### CAGAYAN PROVINCE.

The capitol of Cagayan Province was constructed under the American régime in 1911, before the present policy of the administration was in full force.

The first-story walls are of reinforced concrete with a hardwood interior and tile floor. The second story was constructed of hardwood throughout.

The location of the capitol is somewhat different from most capitols. It forms one of a group of four buildings around a small plaza.

The municipal building and the combined jail and courthouse are all new reinforced-concrete structures, while the church is a magnificent Spanish structure.

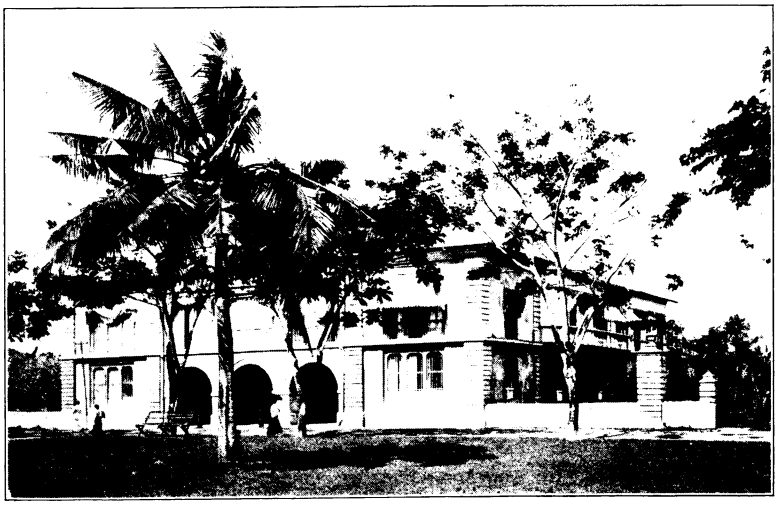
It is to be regretted that no opportunity is permitted for parking or expansion.

### CAPIZ PROVINCE.

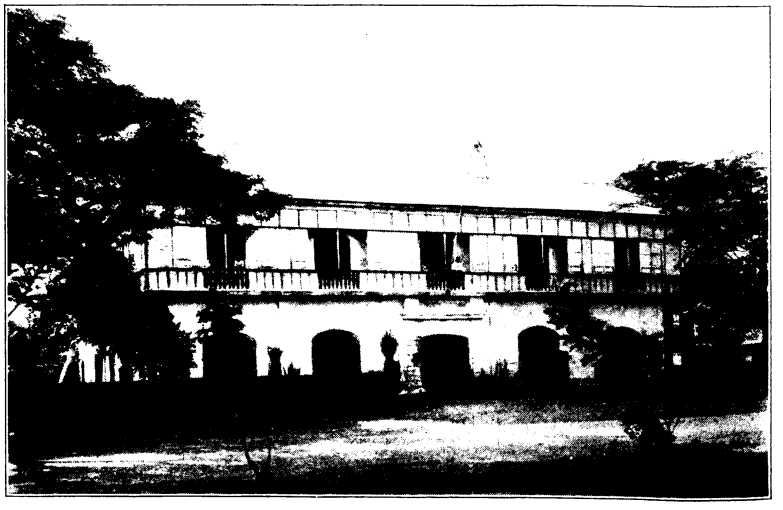
The new capitol for Capiz Province is of reinforced concrete.

The foundation question was somewhat similar to that of the Laguna capitol hereafter described. The site of building was an old fill in a swamp. Here a foundation was prepared by compacting large adobe rocks with an 8 and 10 ton road roller over the entire area of 1,120 square meters.

The grounds around the building have been laid out with tennis court, walks, lawns, hedges, and both ornamental and shade trees.



The provincial government building of Ambos Camarines at Nueva Caceres.



Facade of provincial building of Bataan, at Balanga.

Back view, Bataan provincial building, built in 1792–1794.

CAVITE PROVINCE.

This capitol is one of the few of the Spanish constructed buildings that still retain the tile roof. It was constructed in 1820 and is still in good state of preservation.

The first-story walls are of heavy adobe and masonry, while the floor is raised somewhat above the street level by an adobe-stone fill with a concrete capping. The second-story walls and floors are of native woods. Glass panes in place of the customary shell are used in the windows.

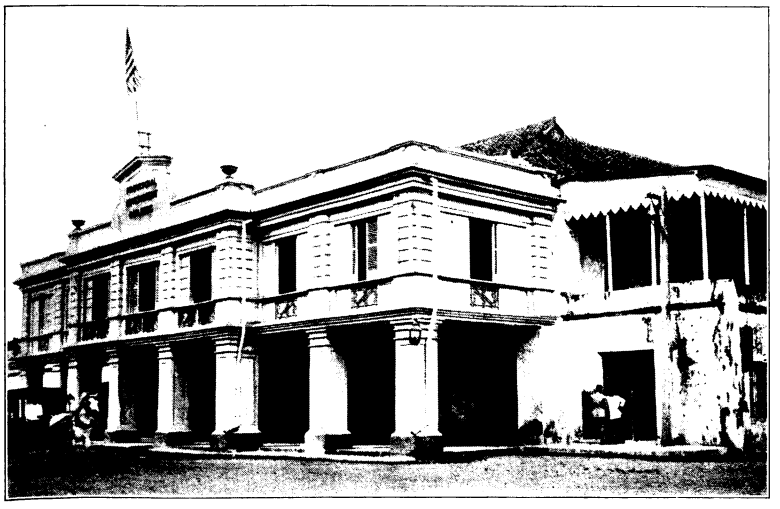
The first floor is used for prison and storerooms, while all the offices are on the second floor.

There is no room for expansion or for parking in this location, it being in the center of a business section which occupies the whole of the small peninsula not otherwise owned and occupied by the United States Navy.

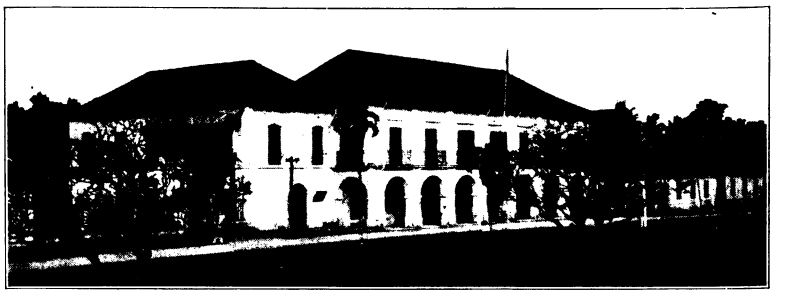
CEBU PROVINCE.

In Cebu Province the present capitol is of Spanish design constructed of cut coral for the first-story walls and native hardwoods for the second story. In plan it was expansive with a fine entrance and stairway to the second story. The ground floor is paved with two colors of tile, while the second-story floor is of native hardwood.

This building occupies about one-third of a neatly fenced-in block containing about 4,000 square meters and faces a large municipal park which has been laid out with footpaths, shrubbery, and trees, so that it serves the people of Cebu as a Luneta for the evening concert and promenade.



Batangas provincial building, Batangas.



Provincial capitol of Bohol Province, built in 1860.

A good water and sewer installation has made the building modern in many respects, but it is much too small for the present needs. Accordingly a new government center has been designed on rising ground overlooking the business section and the ocean about 2 kilometers distant from the port.

The Osmeña Fountain, a high reinforced-concrete construction at the head of the main boulevard of Cebu, is the center around which are to be located the different provincial and insular buildings and from which the main provincial highways will radiate. The situation is ideal for the successful carrying out of the present policy relative to government centers.

ILOCOS NORTE PROVINCE.

The Ilocos Norte capitol is an old Spanish designed and constructed building of brick and lime mixture for both stories. This building, though unattractive in appearance, serves its purpose well. The maintenance since 1905 has cost the province ₱17,392.96.

There are no plans for a new center nor much chance for expansion on the present location, but the provincial officials are improving the attractiveness of the place by planting trees and shrubbery on either side of building.

ILOCOS SUR PROVINCE.

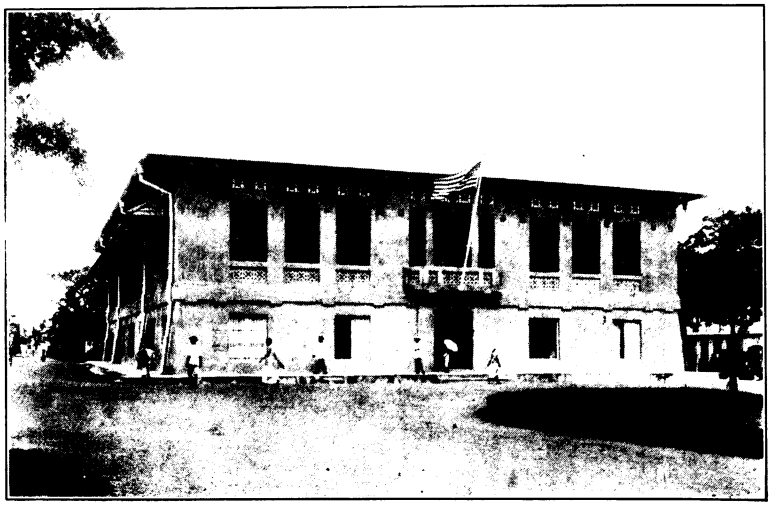
The capitol of Ilocos Sur Province is of Spanish construction of about the year 1800.

The walls, interior and exterior for both floors, are of cut coral encasing a lime-mortar masonry to the roof elevation. The piers extend to the second floor elevation only. All wood is of superior native growth.

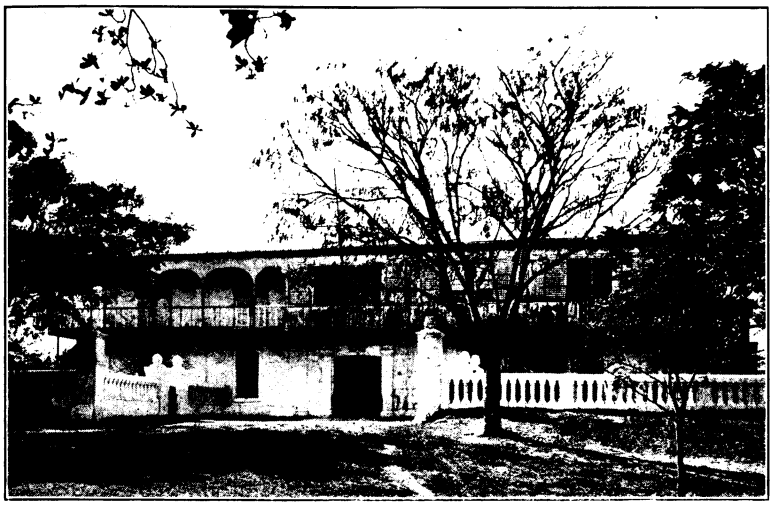
Considerable reconstruction was done from 1903 to 1906.

The first appearance of the building is very attractive with its neat fence and shrubbery.

A view of the rear of the building gives a good example of the Spanish architecture as applied to the portion of building not seen by travelers on the road.



Capiz provincial building at Capiz.



The provincial government building of Ilocos Sur Province at Vigan, looking west. Spanish structure.

This building is not adequate for the present needs of the provincial officials and an endeavor is being made to finance a project for a new provincial center along modern lines.

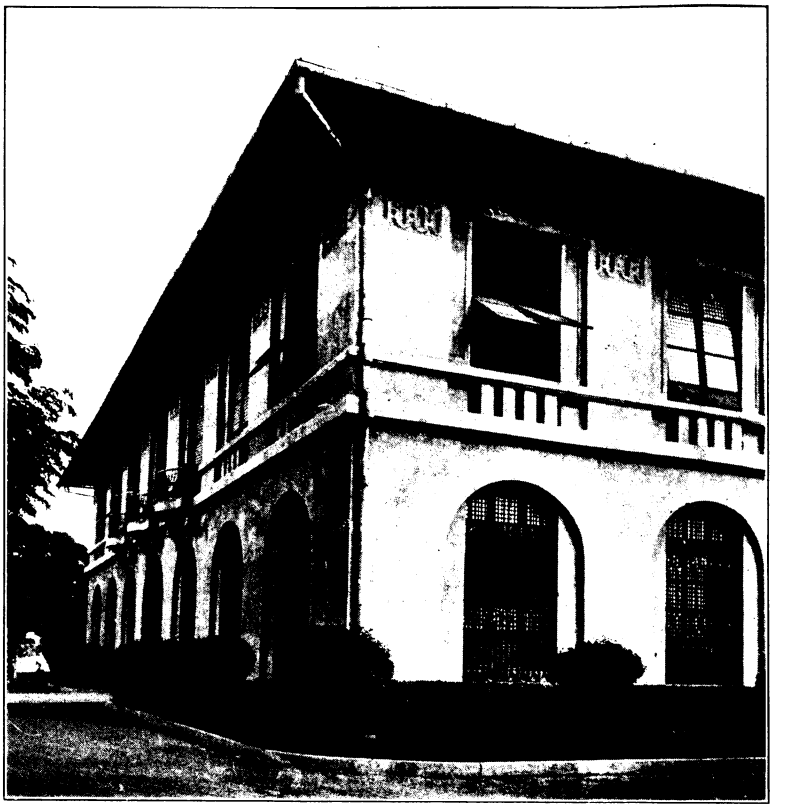
ILOILO PROVINCE.

The capitol of Iloilo Province is a reconstructed Spanish building that was formerly used as the official residence of the provincial governor.

The first-story walls are constructed of adobe and coral stone with a cement plaster finish, while the floor is of a tile construction. The second-story walls are of reinforced concrete, with the floors, doors, windows, and framings of native hardwoods.

The second-story of the old building, which was constructed in 1872, had a wall construction that was common in that day and is still followed to some extent in the Philippines. Native hardwood posts were erected on the first-story walls and a split bamboo framing was set up in the panels between the posts. A lime and sand mortar was then applied to the bamboo framework similar to the modern Hy-Rib concrete partitions of to-day. This construction is known in the Philippines as "pampango."

In the development of the approved parking plan of the Consulting Architect, footpaths are being laid out and lawns started by the planting of Bermuda grass.



Rear face of Pampanga provincial building, Pampanga Province.

ISABELA PROVINCE.

The capitol of Isabela Province is of American design and construction.

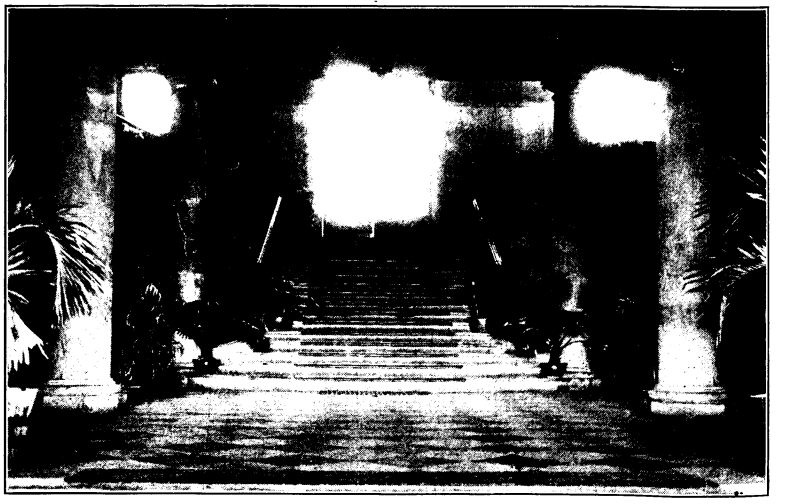
The materials employed were concrete for piers and foundations, and native hardwoods for all other portions, except the partitions and ceiling which were of Oregon pine, and the roof which was of galvanized iron.

The parking system forming a part of this provincial center is very elaborate and well executed.

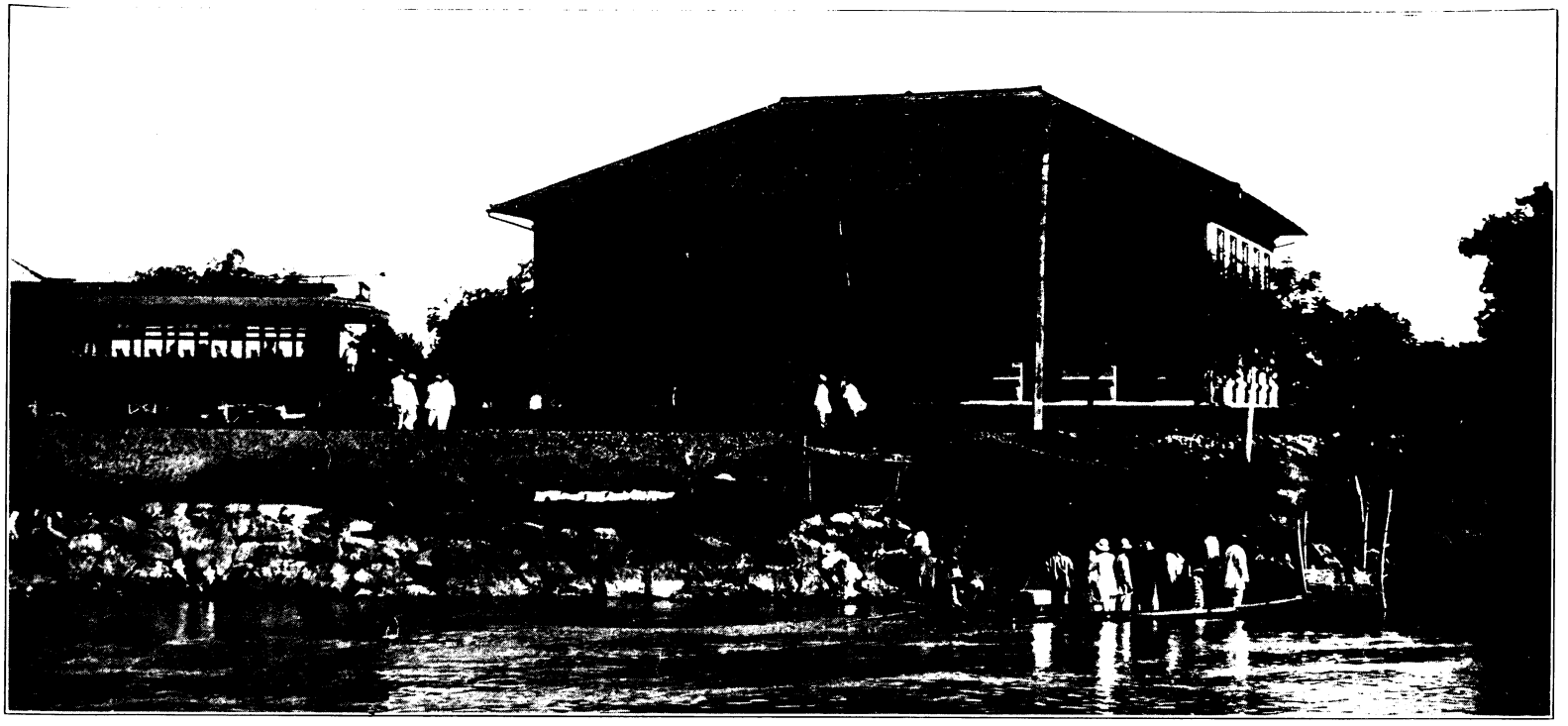
LAGUNA PROVINCE.

In Laguna Province there is perhaps the most imposing capitol yet constructed under the American régime. It is of the box type

Provincial Capitol, Ilocos Sur. To left shows modern Spanish architecture. To right shows Spanish architecture of early and middle of nineteenth century.



Interior of provincial building at San Fernando, Pampanga Province.



Pasig provincial building, at Pasig, Rizal.

of reinforced-concrete building with a facade of Roman Doric columns. The first-story floor is of tile and the second of native wood (supa), both on a concrete base.

The site upon which this building is located is a flat plain a kilometer distant from the business section. The subsoil was found to be very soft and, as a foundation for the building, a large reinforced-concrete continuous slab for the entire area of the building was constructed upon which the structure was built.

In the work of improving the grounds surrounding the building curbings have been built, grading and sodding done, box hedges and ornamental shrubbery started. A large artesian well on the grounds supplies water for sanitary and parking purposes.

### LA UNION PROVINCE.

The La Union capitol is of Spanish design and construction.

The lower-story walls are made of cut coral in parallel rows filled in between with lime mortar and rubble masonry, while the second story is of native timber.

### LEYTE PROVINCE.

The capitol of Leyte Province is a softwood construction of early American administration. It is of one story only and covers an area of 1,100 square meters located on a site of about 3 hectares.

In 1912 there was some discussion for a new capitol to be commensurate with the importance of the province costing ₱150,000, but it resulted in no effective action being taken. No provincial improvements worthy of the name have been undertaken or proposed.

### MISAMIS PROVINCE.

The capitol of Misamis Province is not worthy of much comment. It is of old Spanish construction with adobe walls for first-story and mixed woods for second-story construction, with a bamboo and pole framing to carry the nipa roof. It is very poorly situated for modern requirements, with little or no room for expansion unless heavy real estate purchases are made.

The sum of ₱5,987.32 has been spent in reconstruction work, prin-

Provincial building, Sorsogon.

View of provincial building, repaired by Bureau of Public Works, Surigao Province.

cipally in the construction of a reinforced-concrete record vault. This province has excellent opportunities for the promotion of a new government center, if financial considerations were favorable for such a project.

NUEVA ECIJA PROVINCE.

The location of the recently approved provincial center for Nueva Ecija is about a kilometer from the business center of Cabanatuan. The plan of this center gives promise of a delightful appearing center, while the geologic and other conditions are ideal for the successful completion of this project.

The capitol, jail, and storehouse shown on the plan of this article have already been completed and are of reinforced concrete.

The capitol is of the square box type with a tile roof. The first floor is of tile and the second floor of wood on a reinforced-concrete girder and slab construction.

Betterment work is now in progress on these center plans and will continue as rapidly as funds are available for it.

OCCIDENTAL NEGROS PROVINCE.

In Occidental Negros the present provincial government has two office buildings to carry on its work in. Both of these were originally private residences, one of which was purchased for ₱22,500 and the smaller one for ₱8,000 in 1911.

In the large building the first-story walls are of lime-pebble masonry, while the second story is of native hardwood throughout. The smaller building is in poor condition and should be replaced. The chief cause of destruction of timber construction in this province are the white ants.

The present provincial buildings and their surroundings are very poor and there seems to be no immediate likelihood for a modern provincial center, though the province owns approximately 18,000 square meters of land where the present buildings stand.

ORIENTAL NEGROS PROVINCE.

This capitol was until 1907 a private residence of Spanish construction located on the beach in a lot of 2,000 square meters.

The first-story walls are of cut-coral masonry, while the second story is of native hardwoods.

During the last three years considerable reconstruction work and additions have been made to this building that have made for convenience and for ornamentation.

An excellent concrete fence has been constructed, curbs placed, and flowering vines grown. The size of the lot and the location are such that expansion and parking cannot be considered.

PAMPANGA PROVINCE.

This capitol, constructed in 1907 and 1908, was of reinforced-concrete design and was one of the earliest of this type of provincial capitols. All the foundations, footings, piers, exterior and interior walls, floors, floor girders, columns, and stairs are of reinforced concrete.

The main entrance and stairways have a tile surface, while the office floors are of hardwood laid on top of the concrete.

The concrete surfaces of the building were carefully treated in construction and every pains taken to secure a handsomely constructed building.

The roof covering is of 26-gauge galvanized iron which was the only gauge available at the time of the construction. It is painted red and helps out in the color scheme, as many of the flowering plants on the lawn are of the same color.

This province was also the first to do any extensive parking and commenced in 1906 by securing 127,179.91 square meters of excellent real estate about 2 kilometers from the business center.

In the parking scheme about 2 kilometers of excellent drives have been constructed, trees and shrubbery introduced, athletic fields and playgrounds finished, an excellent reinforced-concrete provincial prison built, and a high school constructed.

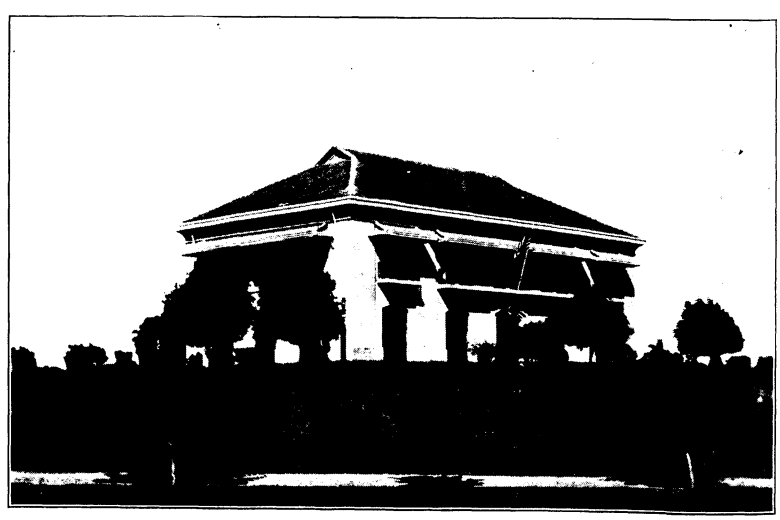
As a result of the foresight and initiative of the provincial officials of this province the present generation are securing an enjoyment and training far in advance of most of their fellow citizens in other parts of the islands.

PANGASINAN PROVINCE.

The present capitol is a structure of old Spanish design constructed in 1885. The first-story walls were constructed of brick with a stucco finish, and the second story of native hardwoods.

The first floor is brick and the second floor wood. Considerable repair work has been done in the past due to the destructive work of white ants and dry rot. In 1901 and 1902 there was an expenditure of ₱3,500 under the provincial supervisor, while from 1906 to 1912 ₱36,478.65 was expended on reconstruction by the provincial treasurer in making the building safe for occupancy. This shows reconstruction expenses of practically ₱40,000 on a building that, from the most authentic sources available, cost only ₱30 000 to construct.

Because of the unsatisfactory present situation as relates to convenience, size, space, and the cost to purchase the adjacent properties in the center of Lingayen for parking, the provincial board has under consideration the construction of a new provincial center as described by the Consulting Architect. The site selected comprises approximately 25 hectares bordering the Lingayen Gulf and the approved



Tarlac provincial building.

plan as herein shown calls for a capitol, jail, garage and storehouse, trade school, intermediate school, playgrounds, courthouse, and residences for the provincial governor and treasurer—all these structures to be of reinforced concrete. This proposed center is the most elaborate yet projected and is estimated to cost ₱500,000 to complete. Its undertaking and successful completion will give the Philippine Islands a provincial center that the projectors may well be proud of, one that should serve as a model for better civic improvements in the municipalities of this and other provinces.

### RIZAL PROVINCE.

The capitol of Rizal Province was the first reinforced-concrete type constructed and marks a distinct era in the policy governing provincial capitols.

The construction is practically the same throughout as the other buildings of this type already described.

The Manila Electric Railroad has a line passing between the building and the Pasig River with a waiting shed in close proximity. Some box hedges and a few trees have been planted, but there still remains a great opportunity for beautifying. A good river wall for the entire length of the grounds, with either a flat or terraced lawn laid out with walks and flowers from the river to the provincial building, would be a treat and an education to municipal or other officials that continually pass this building on the river and lake steamers.

### SAMAR PROVINCE.

The Province of Samar like Antique is occupying the municipal building for its provincial offices on a rental basis of ₱100 per month. The province owns no site for a new center nor does there seem to be any likelihood of any project toward this end being undertaken in the near future.

### SORSOGON PROVINCE.

The Province of Sorsogon has no provincial capitol at this time. The officials are occupying the west wing of the provincial high school.

The Consulting Architect, however, is preparing plans for a new provincial center that will provide for a capitol, a jail, and a large parking scheme covering 11 hectares.

The estimated cost of this complete project approaches ₱200,000.

### SURIGAO PROVINCE.

In Surigao Province the capitol has an excellent location on the beach facing the plaza.

The building is constructed of cut-coral masonry for the first story and hardwood for the second story. Practically the entire woodwork of the building has been replaced during the last six years.

The yard in front of the building is inclosed with an attractive brick fence, while the small inclosure is most artistically laid out and cared for.

A tract of land adjoining the building and bordering the beach containing about 6,000 square meters is owned by the province and will be used for a park. On account of the plentiful rains and rich soil of the country it is very easy to grow flowers, shrubs, and trees, while orchids are very plentiful and abound in the trees of the public streets.

The port is 1.2 kilometers from the capitol and the business center. An excellent road shaded with high acacia trees planted in Spanish days connects the port with the town.

### TARLAC PROVINCE.

Probably the most commanding capitol can be found in Tarlac where the building is located on a small hill in a government center site of 3 hectares presented to the province by Mr. James Hill of Tarlac. The capitol overlooks the adjacent country for a large area.

The building itself is of reinforced concrete with the exception of some of the office partitions and roof framing for carrying the tile roof. The first floor is tile resting on a concrete base, while the second floor is of wood on a reinforced-concrete girder and slab construction.

A new reinforced-concrete jail has recently been completed as a factor in this provincial center arrangement.

The parking work carried on is extremely effective and the whole combination is beautiful to look upon.

### TAYABAS PROVINCE.

Tayabas Province is one of the owners of a new reinforced-concrete capitol built on lines described for Pampanga and Rizal.

In situation it is somewhat removed from the business center but near the railroad center for Lucena. The Provincial grounds are quite extensive and the soil will grow almost anything of tropical flora.

The provincial grounds have been fenced in, a reinforced-concrete jail constructed, and other improvements are contemplated when more money is available.

### ZAMBALES PROVINCE.

The present capitol of Zambales Province is the old Spanish jail. It is a brick structure of one story, constructed about 1860, and incloses a square 40.7 by 49.05 meters.

Since 1911 the clay-tile floor has been replaced with colored cement tiles, the ceilings have been sheathed with beaded lumber, the interior office walls have been plastered with cement mortar and white washed, plumbing has been installed, and the roof painted with "De-Co" paint.

This building contains 14 rooms of which 4 are used for the prison.

The provincial grounds adjoining this building have been neatly fenced in, two tennis courts constructed, and the rest is parked with lawns and flowers, making an attractive and much used pleasure resort for the people of Iba.

## PROVINCIAL CAPITOLS.

| Provinces. | Capital. | Type of construction and class of material. | Roof. | Assessed value old work left in reconstruction. | Actual cost of new construction. | Asset value from provincial treasurer. | Appraised value by district engineer. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| Albay | Albay | Reconstructed Spanish building; first story lime masonry and second story reinforced concrete. | Galvanized iron | ₱33,173.69 | ₱70,165.87 | ₱100,000.00 | ₱95,941.98 | Reconstructed in 1907 and 1908. |
| Ambos Camarines | Nueva Caceres | Reconstructed Spanish building; first story of lime-lava masonry and second story of masonry and native hardwoods. | do | 12,556.71 | 37,443.29 | 50,000.00 | 50,000.00 | Reconstruction was made necessary because of damage inflicted by earthquake of April, 1907. |
| Antique | San José | | | | | | | This province has no provincial capitol but occupies a municipal building. |
| Bataan | Balañga | Spanish building of cut adobe stone walls for both stories. | Galvanized iron | | | 70,300.00 | 90,000.00 | Oldest provincial capitol in Philippines; constructed in 1792–1794. |
| Batangas | Batangas | Spanish building with first story of cut adobe stone and second story of native hardwoods. | Galvanized iron and Spanish clay tile. | | | 50,000.00 | 50,000.00 | Excellent example of the middle nineteenth century Spanish architecture in the Philippines. |
| Bohol | Tagbilaran | Two-story Spanish building constructed of solid cut coral stone masonry. | Galvanized iron | | | 52,000.00 | 70,000.00 | Constructed in 1860. Is an excellent example of Spanish architecture of that period in the Philippines. |
| Bulacan | Malolos | American construction of Oregon pine, except for native hardwood framing on adobe stone foundations. | do | | 38,766.90 | 39,745.00 | 45,000.00 | This is one of the three capitols constructed of wood under American administration; it is of one story, built in 1904. |
| Cagayan | Tuguegarao | American construction; first story of reinforced concrete and second story of native hardwoods. | do | | 57,286.65 | 57,286.65 | 57,286.65 | Completed in 1911. |
| Capiz | Capiz | American construction; two story reinforced concrete. | Flat tile | | 113,911.75 | 113,911.75 | 116,880.70 | Completed in 1912. |
| Cavite | Cavite | Spanish building with first story of adobe cut stone and second story of native hardwood. | Spanish tile | | | 55,280.00 | 55,280.00 | Constructed in 1820; there have been some additions and repairs under American administration. |
| Cebu | Cebu | Spanish building with first story lime-pebble masonry with cut-coral face and second story of native wood. | Galvanized iron | | | 94,000.00 | 70,000.00 | This building has been equipped with sanitary fittings of all kinds, and much of the timber has been replaced under American administration. |
| Ilocos Norte | Laoag | Spanish building of brick and lime mortar for two stories. | do | | | 75,000.00 | 60,000.00 | Maintenance cost since 1908 approximates ₱20,000. |
| Ilocos Sur | Vigan | Spanish building of lime mortar, cut stone, and brick masonry for two stories. | do | | | 35,127.60 | 22,000.00 | This building was constructed about 1800. A few additions to original structure have been made. |
| Iloilo | Iloilo | Reconstruction of cut adobe and coral Spanish construction with reinforced concrete. | Flat tile | 34,492.43 | 134,954.27 | 166,444.56 | 169,446.80 | The original building was constructed in 1872; reconstruction was started in November, 1908, and completed the following year. |
| Isabela | Ilagan | American construction of native hardwoods on a concrete foundation. | Galvanized iron | | 41,521.61 | 41,521.61 | 41,521.61 | Constructed in 1911; the only two-story capitol constructed of wood; native hardwoods were used. |
| Laguna | Santa Cruz | American construction of reinforced concrete for entire building. | do | | 114,312.45 | 114,312.45 | 114,312.45 | This building has an imposing facade of Roman Doric columns that distinguishes it from other provincial capitols; built in 1908 and 1909. |
| La Union | San Fernando | Spanish building of masonry walls faced with cut coral for first story and timber for second story. | do | | 55,000.00 | | 55,000.00 | Constructed in 1850. |
| Leyte | Tacloban | American timber construction of one story. | do | | | 8,196.65 | 8,196.65 | After the November, 1912, typhoon, about ₱3,500 was spent on repairs. |
| Misamis | Cagayan | Spanish two-story building; first story of cut adobe masonry and second story of mixed woods. | Nipa | | | 7,000.00 | 12,000.00 | An old Spanish building; is very inconvenient in arrangement. |
| Nueva Ecija | Cabanatuan | American constrution of reinforced concrete. | Flat tile | | 77,000.00 | 77,000.00 | 77,000.00 | This building is located in one of the new parking schemes. |
| Occidental Negros | Bacolod | Spanish building of lime-gravel masonry for first story and native hardwoods for second story. | Galvanized iron | | 22,500.00 | 20,219.04 | 30,000.00 | The provincial officials occupy two buildings both formerly private residences; only the larger is considered; actual cost is purchase price. |
| Oriental Negros | Dumaguete | Spanish building; first story of cut coral and second story is of native hardwoods. | do | 11,039.01 | 11,500.00 | 21,539.01 | 21,539.01 | This building was formerly a private house that was purchased in July, 1907, for ₱11,039.01. |
| Pampanga | San Fernando | American construction of reinforced concrete for two stories. | do | | 85,000.00 | 85,000.00 | 85,000.00 | Constructed in 1907 and 1908. |
| Pangasinan | Lingayen | Spanish construction with first story of brick and stucco and second story of native timber. | do | | | 25,000.00 | 15,000.00 | Erected in 1885; inadequate for present day needs; ₱39,978.65 spent in reconstruction and repair since 1901. |
| Rizal | Pasig | American construction of reinforced concrete for two stories. | Flat tile | | 111,583.69 | 111,583.69 | 111,583.69 | Erected in 1906; was first capitol of this type constructed. |
| Samar | Catbalogan | | | | | | | This province has no provincial capitol, but rents a building from the municipality. |
| Sorsogon | Sorsogon | | | | | | | Province has no provincial capitol, but occupies a wing of the high school building. |
| Surigao | Surigao | Spanish building repaired first story coral masonry; second story native hardwoods. | Galvanized iron | | | 6,168.94 | 10,000.00 | Has excellent location on the ocean front. |
| Tarlac | Tarlac | American construction of reinforced concrete for two stories. | Flat tile | | 71,031.69 | 71,031.69 | 71,031.69 | This capitol is the most commanding of all the capitols; constructed in 1909. |
| Tayabas | Lucena | American construction of reinforced concrete for two stories. | Galvanized iron | | 90,000.00 | 90,000.00 | 90,000.00 | Completed and accepted Oct. 29, 1908. |
| Zambales | Iba | Spanish design; one story brick around a square courtyard. | do | | | 35,000.00 | 35,000.00 | Formerly the provincial jail; in repair and reconstruction ₱5,042.53 has been spent. |

In summarizing this tabulation of provincial capitols we have 3 provinces that own no capitol building—Antique, Samar, and Sorsogon; 3 have modern buildings by reconstructing the Spanish building—Albay, Ambos Camarines, and Iloilo; 14 Spanish buildings—Bataan, Batangas, Bohol, Cavite, Cebu, Ilocos Norte, Ilocos Sur, La Union, Misamis, Occidental Negros, Oriental Negros, Pangasinán, Surigao, and Zambales; 3 of American wood construction—Bulacan, Isabela, and Leyte; 1 of mixed materials, concrete and wood—Cagayan; and 7 capitol buildings of the latest reinforced-concrete design—Capiz, Laguna, Nueva Ecija, Pampanga, Rizal, Tarlac, and Tayabas.

Of the 14 old Spanish capitols remaining, 3 are of brick, stone, and lime mortar masonry—Ilocos Norte, Ilocos Sur, and Zambales; 1 of solid cut coral—Bohol; 1 of cut adobe stone—Bataan; and 9 of masonry first story and native wood second story—Batangas, Cavite, Cebu, La Union, Misamis, Occidental Negros, Oriental Negros, Pangasinan, and Surigao.

Of the 28 provincial capitols, 20 have galvanized iron, 1 nipa, 1 Spanish tile, 1 mixed galvanized iron and Spanish tile, and 5 flat tile roofs.

## SOUNDINGS.

Compiled by J. L. HARRISON, District Engineer, from data submitted by A. E. HALEY, Assistant Engineer, Bulacan Province.

Whenever a permanent structure is to be erected a careful determination of the character of the materials underlying the site on which it is to be erected must be undertaken. The extensiveness of this determination as well as its necessary accuracy depends on a number of factors all of which have generally been roughly determined before the work of sounding is taken up. Chief among these factors may be mentioned (1) the weight of the proposed structure, (2) its general type, (3) its value, and (4) the previously known general character of the substrata in the region where it is to be erected. These factors must be carefully considered, for the successful engineer should avoid unnecessarily extensive, and hence unnecessarily costly, testing as carefully as he does the securing of too little information.

Very heavy structures are extremely rare in the Philippine Islands. Hence a discussion of the extensive sounding required before such structures are erected would be of little interest here. Every engineer should, however, recognize the fact that the total weight of a large structure is often as important a subject for consideration as is the unit load on its footings. The reason for this is found in the fact that the weight of any structure must be carried down through all of the strata that underlie it. But it often happens that, though the surface strata will carry 2 or 3 tons per square foot, they will not carry a heavy structure because of a soft underlying stratum which is displaced by the added weight of a heavy structure. This displacement of the softer stratum allows the upper strata to sag. Usually excessive and uneven settlement is all that results, but there are cases on record where failure to detect an underlying soft stratum has resulted in the total loss of valuable structures. It is, therefore, advisable to estimate the total weight of any contemplated structure in order that all soundings made on the site where it is to be erected may be carried to such a depth that if a weak stratum, dangerous to its stability, exists it will be discovered.

The kind of structure to be built, the material to be used, and the type that has been selected all affect the accuracy of the foundation data needed and its extensiveness. Inasmuch as settlement cracks in buildings are particularly undesirable and unsightly and always result in unfavorable comment on the reliability of engineers in general, great care should be taken to protect buildings from uneven settlement by providing those who are responsible for designing them with accurate information concerning the foundations on which they are to rest. Sufficient emphasis has not always been placed on this matter. As a result, a number of buildings have settled badly and responsible engineers have been very seriously criticised. Bridges are more exposed than are buildings, but the uneven settlement of a bridge is not as important or as conspicuous as is the uneven settlement of a building. A structure built of steel adjusts itself to unequal settlement much more readily than does one built of concrete. A reinforced-concrete structure is affected differently by settlement than is a structure of brick or stone. The type of structure is also important. A truss is practically unaffected by settlement that would wreck an arch. The engineer who is gathering data concerning the footings for various kinds and types of structures must expect, therefore, to spend more time and money, other things being equal, in securing data concerning the strata underlying an expensive building than he would spend in securing data as to the strata underlying an equally expensive bridge, just as he should spend more time and money in determining the strata underlying an expensive stone arch than he would spend in examining the strata underlying a steel bridge.

Every engineer should learn all that he can of the geology of the region in which he works. Such knowledge will greatly influence decision on the number of holes needed for the proper determination of underlying strata throughout this region. Careful observation of local geology will also assist. For instance, the knowledge that large parts of the city of Manila rest on what may be termed a thin "crust" under which is a stratum of unstable ooze makes it unnecessary to sound this region as extensively, when new buildings are erected, as would be advisable were the lower strata more solid but less uniform. Wherever large rivers have built extensive deltas much this same condition prevails, and wherever it does prevail about all the data an engineer should ordinarily try to get is the thickness of the crust, the materials of which it is composed, and the composition and consistency of the unstable stratum. Whole regions in the Philippine Islands are overlaid with volcanic ash. When such a stratum is encountered, if the first sounding shows a satisfactory depth of this material, to extend other soundings through it is a foolish expenditure of time and money, for volcanic strata have been recently and very evenly deposited, and within the area occupied by any one structure are not likely to vary in thickness. Much the same can be said of rock ledges. When the first test hole drilled has demonstrated the proper thickness of a ledge other soundings should be made to the solid rock but not into it. On the other hand, strata of gravel and sand are so variable that no assumptions as to their depth or extensiveness should ever be made. Where they exist and where clay exists each test hole should be put down to the full depth previously determined on as necessary for this locality, and because of the irregularity of the strata composed of these materials, more holes must be sunk than are necessary where the strata are composed of materials more uniformly laid.

From this it should be seen that the problem before the engineer is not one of getting all of the data obtainable, but of getting all that the importance of the structure will warrant and of insuring that what is secured is as accurate as it can be made for the money that can be reasonably spent in securing it. This requires a keen perception of the problem in hand and good judgment. Engineers should also bear in mind that whatever data are furnished must be interpreted by designers who have never seen the locality treated of, and by contractors who depend on them for information concerning many features of whatever work is contemplated. Therefore, the record of all soundings should be so clear that all can easily understand it, and so accurate that it will not be called in question by even a carping contractor.

On the other hand, those who rely on these borings should realize that they are not photographic reproductions of subsurface conditions. Like all matters depending on human effort and human judgment they are subject to inaccuracies of one sort or another. These inaccuracies should not be of much consequence, but occasionally important conditions may entirely escape notice. Also it sometimes happens that what at first seems to have been a very erroneous determination of the materials lying below the surface will, when impartially examined, prove to have been a very reasonable and natural determination if all of the evidence brought to light by the sounding apparatus is reëxamined. This is, of course, due to the fact that the sounding apparatus makes only a small hole and brings to the surface only small samples. Therefore, before severe criticism is leveled at engineers who have been responsible for incomplete reports on underground conditions those feeling critically inclined ought to consider the reasons for this lack of completeness. It is manifestly unfair to pretend that an engineer can secure as accurate data through a 2-inch hole as can later be obtained from an open excavation, though my personal experience has led me to believe that the only material some people can see, even in an excavation, is gravel.

Almost all of the structures erected in the Philippine Islands are comparatively light. A hand outfit, therefore, is heavy enough for ordinary soundings. Such an outfit is composed of a churn drill to cut the hole, a jet to keep the hole clear, augers for taking samples, and various other incidental apparatus such as a derrick on which to handle the jet, casing pipe to keep the hole from caving in, jacks for lifting the casing pipe and a hammer for driving it, and a full set of tackle and necessary small tools. It is well to see that there are plenty of these small tools, for a shortage of tools always means delays and delays are expensive.

When a hole is to be sunk with this outfit the derrick is set up, the casing prepared, and the drill and jet connected with the pump. It is frequently a good idea to start the hole by running the jet down

into the ground 2 or 3 meters. This is not necessary, but as it makes the driving of the first lengths of casing easier it is often a convenient thing to do. As soon as the least difficulty is encountered the casing pipe must be started.

The casing pipe is usually a pipe 2 inches in diameter. It is cut into short lenghts, because long lengths are likely to hinder the operation of the drills and augers. This pipe is driven to insure that no extra material is handled. It should be allowed to lag behind the drill in firm ground, but should be kept well ahead of it in sand and light gravel. It *must not* be driven even into soft rock. The casing, in short holes, can usually be driven by means of a heavy wooden block, but if deep holes are needed a light iron hammer (150 to 250 kilos) rigged in the derrick should be used. However, an iron hammer must be handled carefully or the casing pipe will be badly battered. Jacks should be used to draw the casing.

When two or three lengths of the casing pipe are in place the churn drill and jet should be started. The drill is made in any of the standard shapes for chop bits. It is about a foot long and has two holes bored in its sides in such a position that two small streams of water can be caused to play on the surface that it is cutting away. This drill point is attached to a half-inch pipe, and this in turn is attached to a pump by means of a long hose. In operation the drill is lifted from 6 to 10 inches and allowed to drop. No effort should be made to force it down. If the pump is kept running the water it delivers will keep the hole clear and with a free fall the drill will cut fast enough. As the depth of the hole increases the weight of the drill and pipe increase. When this weight becomes too great for three men to handle conveniently, a rope is attached to the pipe carrying the drill and passed over a block hung at the top of the derrick. Any necessary number of men can then be used to lift the drill. In connection with this part of the work a number of points must be remembered: (1) Keep the hole plumb. (2) Keep the drill sharp. A great deal of time will be lost if dull drills are used. (3) Give the drill a quarter turn every time it is lifted. This will keep the hole round. (4) Always keep the pump running when the drill is in use. The drill will cut faster if the bottom of the hole is clean. (5) When two sections of pipe are connected be very careful that they are screwed tight together inside of the union. If this is not done driving the pipe will very probably strip the threads. (6) It sometimes happens that soundings must go through a stratum so full of bowlders that there is no chance of finding a point where they can be avoided and so loose that a hole will not stand without casing. In such a circumstance drill through the obstructing stone to ascertain its size and place a liberal quantity of dynamite as near its center as possible. Draw up the casing pipe a foot or two, tamp well, and fire. The explosion should so crush the bowlder that it will give no further trouble.

As sounding is done for the purpose of determining underground conditions, the most important feature of the work is the securing of the samples of the various strata encountered. These samples should be representative. To make them so, a set of augers and a sand bailer have been provided, but an engineer should remember that even these tools do not prevent queer mistakes. As the drilling proceeds samples should be taken every meter or so. These samples show what is in the bottom of the pipe, but they may not at all represent what is at the same level on the outside of the pipe. For instance, in passing from sand and hard gravel into clay a little sand and small gravel is often preserved. The water from the jet keeps coarse sand suspended, but does not always wash it from the hole, and the softness of the clay prevents the gravel from being broken up. When the drill is stopped the jet is also stopped and the sand settles to the bottom of the hole. An auger sample will then show a clay containing some coarse sand and a little gravel where there is only pure clay. Again, in passing through a layer of sand and clay the jet easily washes out all the clay and all small particles of sand. The coarser sand is suspended about the jet and only gradually removed. When the bailer is put down it often happens that only sand is encountered, though the overflow from the casing may have clearly indicated the presence of clay. Only persistence in sampling and judgment in making determinations will insure accuracy under such conditions as these.

Another fruitful source of error is the clogging of the drive pipe. A stiff clay containing a little sand will sometimes plug the casing. As the casing is often driven 4 or 5 feet at a time, this may be a serious matter for if the pipe is clogged it can be driven through even light gravel without displacing the plug. Of course, when this happens an important stratum may be overlooked. Practically this same thing sometimes may happen if a casing is driven through gravel into a soft stratum. The gravel may arch in the bottom of the pipe and prevents the entrance of other materials. Where it does, gravel will appear in the casing at an elevation much below where it actually lies. To avoid this class of errors keep the drill and jet ahead of the casing pipe wherever this can be safely done.

The consistency of the materials encountered must be determined by the rate of progress made. Rock can be penetrated only very slowly. Mud will wash out very rapidly. Between these extremes lie all sorts of materials with all sorts of consistencies. Good judgment alone will prevent the reporting of soft adobe and soft shale as stiff clay. Even the careful use of augers will not eliminate the necessity of careful consideration as to whether a bit of clay stirred up in cutting and brought to the surface through 30 feet of water came from a putty-like mass or from a bed of tough and compact material. Nor will any number of augers accurately determine whether another stratum is merely stiff clay mixed with coarse sand or is clay and sand carrying some gravel, unless a piece of gravel large enough to hinder drilling or sampling is encountered. Even when rock is encountered it is necessary to determine whether it is hard or soft rock, whether it is thick enough to carry a heavy load, and where the live rock actually begins. For the purpose of determining these questions one hole should enter the ledge at least a meter if very hard rock is encountered or 2 or 3 meters if adobe or shale is found.

To accurately determine what sort of subsurface conditions a given sample represents, one must take into consideration not only the sample itself but also certain general conditions. The materials encountered in putting down test holes may be roughly classed as rock, volcanic ash, gravel, sand, and clay.

As rock is ordinarily found in large masses it seldom gives much trouble. There are, however, exceptions. For instance, large areas near the city of Capiz are overlaid by a blue silt that is so soft that it is frequently called "marine mud." This steadily increases in density until at about 40 feet below the surface it appears to be a pretty stiff blue clay. At 50 feet a sample would ordinarily be classed as shale, though it is not, for it disintegrates in water. Within 25 feet farther the material is so hard that there is no doubt that it is rock. The real question in such a case as this is, "Where does the *rock* begin?" Undoubtedly such gradual variation from mud to rock is rare, but failure to properly sound this very material was largely responsible for the most conspicuous bridge failure that the Bureau of Public Works has ever had, and serves to show conclusively that the determination of even a rock stratum requires judgment. In most cases, however, the important question is the thickness of the rock ledge. To this end the hardest rock should be penetrated far enough to determine its supporting power. This is absolutely necessary, for even a rock stratum will fail if it is overloaded.

In some localities there are heavy strata of volcanic ash. These were originally very evenly laid and those which are now near the surface were laid so recently that they are still quite regular. One or, at the most, two holes sunk 3 meters into such a strata will furnish ample data for even a large structure.

Gravel is never found pure—that is, it is always mixed with some sand and frequently with clay. Gravel is formed in two principal ways: By the disintegration of various rocks and by the grinding up of bowlders in stream beds. Sand is also formed in these two ways. What is usually known as clay is similarly formed, though strictly speaking clay is a product resulting from the disintegration of certain aluminum silicates, chiefly feldspar, and the fine impalpable

water deposits resembling clay are technically known as silt. Because of this double origin of these materials it will readily be seen that all sorts of peculiar combinations may be encountered. For instance, a bed of true clay will almost always contain some quartz sand and more or less frequent chunks of stone that, because of a little greater density, or because they are composed of a little different material than the main body, have resisted disintegration for a longer period. Such beds of clay are very irregular in composition, for the factors that have enabled certain nodules to resist disintegration longer than other nodules have also worked toward leaving more of these hard nodules in some parts of the stratum than are found in other parts. Because of this irregularity such a stratum is very hard to sound accurately, and therefore more soundings are necessary if accurate results are to be secured. In Bulacan Province such a stratum was encountered at the site of the San Rafael bridge. As the first two holes drilled showed no unusual difficulties no more holes were put down at that time. When the contractor began to drive piles he complained bitterly because, with the outfit at his disposal, he was unable to penetrate a stratum which he loudly claimed was a gravel stratum. For purposes of further examination four more test holes were then sunk, and two have been put down since. The first two soundings were made with a jet but without the use of augers. Between the elevations where the contractor claimed that a stratum of gravel existed one of these soundings showed clay and gravel and one only black clay and sand. The second hole was, evidently, put down through a bit of ground that contained no hard gravel. The next four holes were put down with augers and a drill but without a jet. No gravel larger than three-quarters of an inch in diameter was encountered, though all of the holes showed much coarse sand and some small gravel. Almost none of the gravel found was hard gravel. The last two holes were both of them obstructed by large chunks of stone. Later, to ascertain the exact composition of this material a pit was sunk and a large sample taken. This sample weighed 41.5 kilos and contained:

| | | |
|---|---|---|
| Clay easily washed out | kilos | 11.4 |
| Sand | do | 20.1 |
| Pieces over ¼ inch diameter | do | 10.0 |

[N. B.—The weight of the clay probably exceeds the weight of either sand or gravel if the lumps not thoroughly washed apart are considered.]

All of the pieces over ½ inch in diameter were broken to determine their composition. Forty-five percent of these pieces were hard clay. There was, therefore, rather a small percentage of gravel, some of it 3 or 4 inches in diameter, which had not appeared at all in one boring and which did not appear to be large enough to cause trouble until the seventh hole was put down. On the other hand, clay may be almost pure. This is particularly true of those beds of silt which have been deposited at the mouths of rivers and in one way or another have become firm and compact like clay.

Gravel beds may be impregnated with clay or they may be free from this material. Sand is always present. Sand strata like gravel strata are rarely pure. Clay is often present and almost always there is a little gravel. Where the amount of gravel is small it is hard to detect. At the Maasim bridge some of the borings showed gravel and some only sand. The contractor complained that "the plans had shown a gravel stratum as sand," the real cause of the criticism being found in the fact that the driving of concrete piles is hindered very materially by a little gravel. The two strata of which he complained were later examined and found to contain by weight, respectively, 9 and 2 per cent of gravel that failed to easily pass a ½-inch screen. The balance of both these strata was coarse sand. Other similar problems could be mentioned. The point to be emphasized is that a realization of the fact that clay usually contains sand and some gravel, that sand almost always contains some gravel, that the exact location of sound rock in a rock stratum is a delicate matter, etc., will not only lead responsible engineers to look more closely for variations from perfect regularity in the strata investigated, but will also help contractors and others who depend on the records furnished by engineers to interpret them rationally. It is not difficult to see that when a 3-foot stratum which carries 95 per cent sand and 5 per cent gravel is sampled through a 2-inch pipe the gravel may be missed entirely. Nor is it hard to see that a stratum composed of sand, the voids of which are packed with clay, may at times appear to be a sandy clay instead of a sand-filled with clay. If this same stratum carries occasional small bowlders they may easily be entirely overlooked, especially if the stratum is not a heavy one. These facts should be known to engineers and contractors alike. Engineers should use them to assist in securing more accurate results and contractors in making reasonable interpretations of the data given to them.

Another feature which should be mentioned as affecting both the extensiveness of the tests undertaken and their accuracy is the geology of a locality. Are the formations encountered old or new? Are they on high ground or low ground; rolling country or flat country; wet land or land well drained? If in a river bed, how long has it followed its present course? Is the country through which it flows rising or falling? Is it a swift or a sluggish stream? If there is gravel in its bed, where does it probably come from? A little effort to intelligently answer such questions as these will enable an engineer to avoid many mistakes and will enable contractors to more accurately interpret the conditions reported by the engineers.

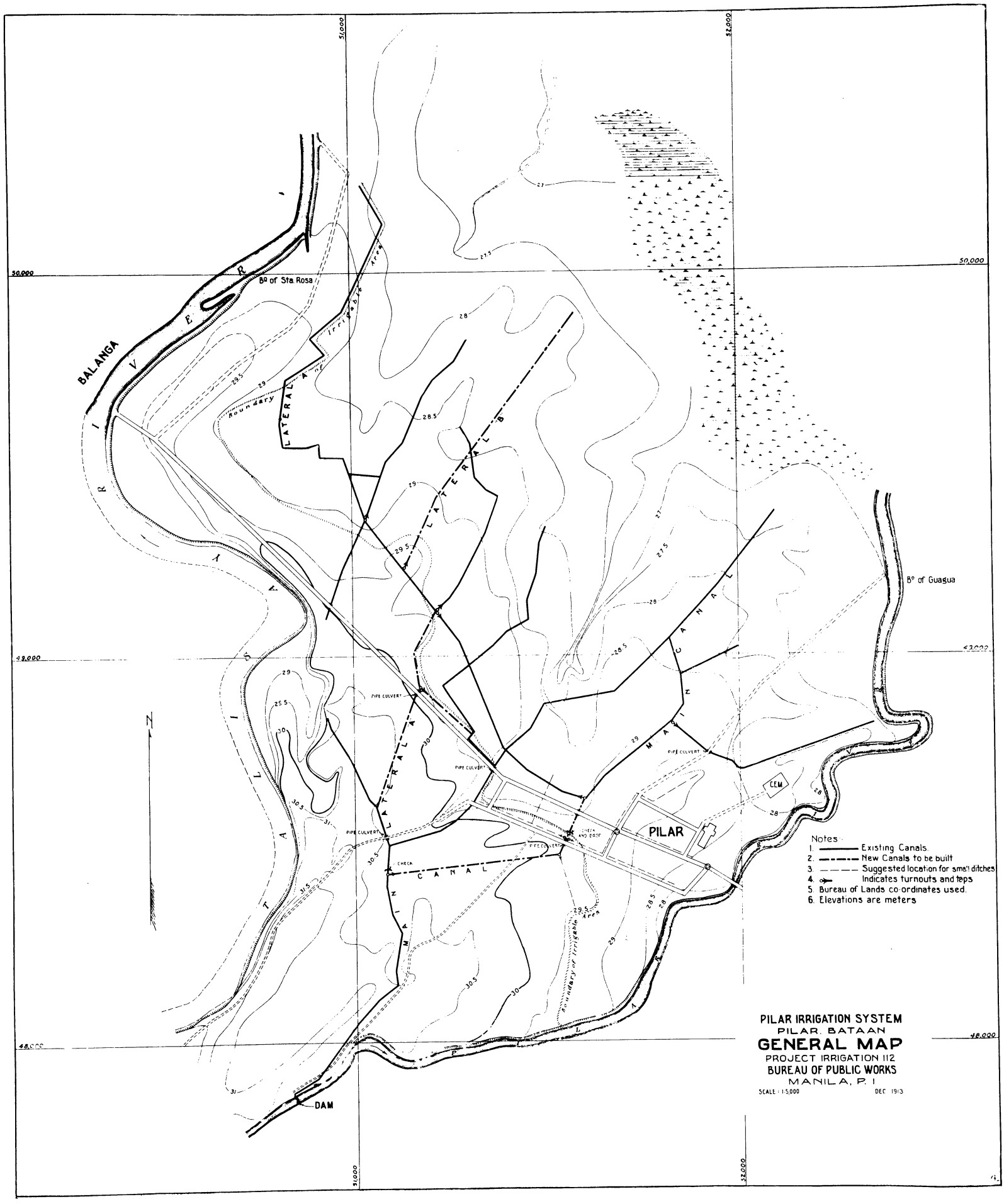
In a recent number of the Bulletin a gentleman who has had a little experience with the driving of concrete piles states that on only four out of fifteen bridges with which he has been connected have the borings been accurate, and then advocates that borings be taken for every bent. It is hard to see just what advantage a contractor, or anyone else for that matter, would gain by such a procedure. As stated before in this article, records of borings are not photographs of the strata encountered. They are careful determinations made from a limited amount of data and based on whatever knowledge and experience an engineer may possess. If they are interpreted with even a very moderate amount of intelligence they will usually be found to check quite well with actual conditions. If this is not true it seems fair to assert that more test holes would be of not the slightest value. The writer has, during the past two years, superintended the tests for some twenty structures constructed and proposed. It is his firm conviction that such differences as have recently been found to exist between actual and reported subsurface conditions have been due to the taking of samples in improper ways and to a failure to realize that different classes of structures require foundation investigations of different degrees of accuracy. The first difficulty has been largely eliminated by providing all engineers with proper sampling augers and the second is being rapidly overcome by a larger experience with the very different types of construction handled by all field engineers. These inaccuracies have occasionally caused serious results but generally such inaccuracy as has existed has been of no importance. The serious assertion that on eleven bridges out of fifteen the soundings have been inaccurate to the extent of inconveniencing a contractor is equivalent to asserting that Bureau of Public Works engineers know rather less about making soundings than could be expected of a ₱50 capataz. Such an assertion is the result of a sadly warped imagination and has no foundation whatever in fact. On the other hand, engineers should understand that inaccuracy in testing substrata may inconvenience those responsible for the construction work to follow and with this in mind should make every effort to render complete reports.

## PILAR IRRIGATION PROJECT.

By JULIAN VALLARTA, District Engineer, Bataan Province.

The Pilar irrigation project is located near the town of Pilar in the Province of Bataan, and occupies the lower portion of the area inclosed by the Pilar River, the Talisay River, and Manila Bay. The project is very small, having an irrigable area of only about 200 hectares, most of which is used for growing rice. The land slopes about 2 meters per kilometer in the direction of Manila Bay. The soil is alluvial and is very fertile.

About the year 1886 the Rosauro interests built an adobe stone


51,000
52,000
50,000
49,000
48,000
BALANGA
RIVER
Bº of Sta. Rosa
Bº of Guagua
Irrigable Area
Boundary
LATERAL A
LATERAL B
MAIN CANAL
PILAR
CEM.
PIPE CULVERT
CHECK AND DROP
CHECK
DAM
Boundary of Irrigable Area
N
Notes:
1. Existing Canals.
2. New Canals to be built
3. Suggested location for small ditches
4. Indicates turnouts and teps
5. Bureau of Lands co-ordinates used.
6. Elevations are meters
PILAR IRRIGATION SYSTEM
PILAR, BATAAN
GENERAL MAP
PROJECT IRRIGATION 112
BUREAU OF PUBLIC WORKS
MANILA, P. I
SCALE: 1:5,000
DEC 1913

dam across the Pilar River at a point about 1 kilometer southwest of Pilar in order to develop water power to run a sugar-cane mill. The water was thus used from December to April, but during the rest of the year it was allowed to run to waste. After the severe droughts of 1903 to 1905 it occurred to a progressive farmer of the district to resort to irrigation in order to insure the success of the rainy-season crop. To secure the right to use the dam for diverting irrigation water from May to November he made the necessary arrangements with the owners and dug a canal to his small farm about 1 kilometer away. After noting the success of this enterprise, the farmers of Pilar, headed by Señor Jose Lerma, then assemblyman of the province, made application to have the system repaired and extended in accordance with the provisions of Act No. 1854, to cover the 200 hectares of land above described. The application was duly approved. The first step taken by the Government was to draw up a contract with the former owners of the dam which provides that all rights to the structure are ceded to the Government, which is to maintain the dam. The Government allows the former owners a certain amount of water during the cane-grinding season to operate their mill.

Construction was begun early in 1909 and finished in the same year. A new concrete deck was laid over the old adobe stone deck and general repairs were made to the old adobe side walls. Three falling steel gates, each 2 meters high by 1.35 meters wide, were installed. A head gate was constructed on each side of the dam, one delivering into the main canal and the other to the sugar mill. The work on the distributing system consisted in repairing and enlarging those canals already in existence, installing several canal structures, and excavating about 2½ kilometers of new laterals. An assistant engineer of the Bureau of Public Works was in charge of the work.

In August, 1911, a severe typhoon occurred accompanied by heavy rainfall which caused exceptionally high water in the Pilar River. The flood carried away the old adobe retaining wall on the south side and succeeding floods tore away part of the deck of the dam. In February, 1913, an investigation of the whole system was made and a design for an entirely new reinforced-concrete dam equipped with falling gates was prepared by the present irrigation division. The old location was chosen for the new structure.

The principal features in the design of the new dam are as follows:

The spillway is 6.8 meters long and is provided with five steel falling gates each 2 meters high, set so as to give about 25 centimeters more head than the former gates. The height of the side retaining walls is 4.95 meters. Above the dam for a distance of 2.5 meters the river bed is paved with adobe stones cemented together with 1:3 mortar. Below the dam the bed of the river for 8 meters is paved with rocks weighing on the average about 70 kilograms each, laid on a 10 per cent slope; and the banks, which were trimmed to a 1 on 2 slope, are paved with adobe blocks. After the first flood it was deemed advisable to bind together the blocks laid in the river bed below the dam with 1:3:6 concrete, and to build a cut-off wall 80 centimeters deep at their downstream edge. The retaining and cut-off walls of the dam proper are founded on hard clay.

Irrigation dam (low water).

Back view of Pilar Dam (low water).

On April 17, 1913, the district engineer was authorized to construct the dam with Government forces. On the 8th of the following month the work was begun. There was a scarcity of labor in Pilar at the time and it was neccessary to bring laborers from the northern towns. At first the laborers were paid from 50 to 60 centavos per day of nine hours, but on June 15 they demanded more money. There being no time to lose, because of the necessity of getting the structure, or at least all masonry work, completed before the next typhoon, the demands of the men were met by making the wages 7 to 8 centavos per hour. This increased the daily wage, but caused the work to progress more rapidly as the men then worked nine to eleven hours per day.

All work was done by hand methods and under the direct supervision of the district engineer. To control the flow of the river, a temporary dam was constructed several meters above the work, from which a temporary flume carried the water over the site of the work to the river channel below. There was considerable seepage water to contend with and four men were kept busy bailing. For the protection of the right bank of the river just below the dam it was found necessary to construct a bamboo mattress 30 centimeters thick by laying the bamboos across each other and wiring them to bamboo stakes driven into the ground 30 centimeters apart.

The sand and gravel were hauled a distance of 2 kilometers from the Talisay River. The adobe paving stones were taken mostly from the ruins of the old dam. The heavy bowlders were hauled from the foot hills, a distance of about 5 kilometers.

It was found that the river bed near the location of the walls had been scoured deeply at the time of the failure of the old dam and had afterwards been filled up with silt. It was necessary to excavate this to hard clay and to prepare a foundation of 1:4:8 concrete therein for the footings of the main walls.

The progress of the work after July 5 was much retarded by continuous rains but, fortunately, on this date only portions of the backfilling and paving remained to be completed.

The dam was finished on July 28. There was general rejoicing among the farmers under the project when it was announced that the job was done, for it insured their 1913 rice crops.

The principal quantities involved in the construction of the dam are as follows:

| | | |
|---|---|---|
| Excavation | cubic meters | 300 |
| Concrete | do | 120 |
| Paving | do | 60 |
| Bamboo mattress | square meters | 100 |

The principal items of the cost are:

| | |
|---|---|
| Labor | ₱3.254.61 |
| Materials | 4,776.12 |
| Surcharges | 1,445.49 |
| Total cost of dam | 9,476.22 |

During the coming dry season, after the crops are harvested, the existing canals will be repaired, some extensions to the system will be made, and permanent canal structures will be installed. It is also planned to provide proper supervision over the distribution of the water so that, by means of proper rotation and the prevention of waste, the methods of operation and the general efficiency of the system will be greatly improved.

## LOCOMOTIVE VS. HANDPOWER TRANSPORTATION ON HIGHWAY CONSTRUCTION.

Transportation in Leyte has always been a serious problem. In the past many difficulties have been encountered and the best prices obtainable have been excessive. The district engineer of Leyte Province submits the following report on progress in solving this problem:

The use of a tramway with laborers pushing the cars was introduced on road construction about two years ago. This method was an improvement upon anything previously attempted, but still the cost of transportation was out of proportion, so it was decided to purchase a locomotive. This was done with a result successful beyond expectation. This locomotive was first used on the Burauen–Dulag section of the Palo–South Road.

The stone is obtained from the Burauen River at a point 1,008 meters in a direct line from kilometer 46.8 of the road. The tramway runs from the quary on a tangent to kilometer 46.8 and then along the shoulder to kilometer 42.9, the beginning of the section. When all the stone is laid from kilometer 46.8 to 42.9, the track will be relaid from kilometer 46.8 to 52.8; as there is a total length of 7 kilometers of tramway it will not be necessary to relay the stretch from kilometer 46.8 to the quarry. Thus 9.9 kilometers of metaling can be placed with only one set of the crusher and a laying of 10.9 kilometers of track.

A word here in regards to laying the track may not be amiss. Care should be taken to have bolts in each fish plate and these should be inspected often to see that none become loose. No ties should be placed under the rail joints. Wooden ties projecting 50 to 70 centimeters beyond the rails on the ditch side lessen the possibility of the track settling so as to cause an accident. In order to prevent spreading and to keep the gauge, it is a good idea to have about three iron ties, which are fastened to the rails with clips and bolts, to every 7 meters of track. If the track shows a tendency to settle, as it will in the case of a new fill, it is a good practice to dump a few cars of stone at this place to be used as ballast. This will insure against further settlement and possible derailments, thereby more than repaying its cost.

A capataz and three men act as a track gang and see that all bolts are kept tight, improve alignment, guard against spreading of rail, inspect cars for loose bolts or bent standards, and in case of an accident help put the cars back on the track.

In order to save time in bringing wrecking tools to the scene of any mishap, a light flat car on which is carried bars, jack, etc., is coupled to the end of the train.

Any time and money employed in maintaining or improving the track is well spent, as thereby the efficiency of the service rendered by the locomotive is increased through more speed and less accidents, burning less coal, and in the depreciation of equipment, which is much greater if the cars are subjected to the constant jerking and jolting which they are bound to receive on a poorly aligned or poorly laid track. Besides the time lost, accidents are costly as one or more boxings, standards, or flanges are almost sure to be broken when a loaded car is derailed.

Laying the tramway cost ₱800, clearing, grading, and building three bridges from the quarry to the road cost ₱300. Putting in wooden ties to add stability to the road bed cost ₱203. Most of these ties would have been required regardless of whether man power or locomotive was used.

In order to obtain a comparison between the costs of hand operation and steam operation laborers were employed during the time the locomotive was being set up in moving the rock. These were under the constant supervision of the foreman who kept them speeded up to the limit.

The average result of a day with hand power:

*Work accomplished.*

15.6 cubic meters delivered, distance 4.9 kilometers = 76.44 kilometers cubic meters.

*Cost.*

| | |
|---|---|
| 1 capataz, at ₱2.40 | ₱2.40 |
| 50 laborers loading and pushing cars, at ₱0.65 | 32.50 |
| Total cost | 34.90 |

Therefore 76.44 kilometer meters cost ₱34.90; 1 kilometer meter cost ₱0.46,[1] or 1 cubic meter ready to spread, ₱2.23.

Average result of a day with locomotive power,

*Work accomplished.*

40.2 cubic meters rock delivered, distance 4.8 kilometers = 192.96 kilometers cubic meter.

*Cost.*

| | |
|---|---|
| 1 capataz, at ₱2.40 | ₱2.40 |
| 1 capataz, at ₱2.00 | 2.00 |
| 25 laborers loading, at ₱0.65 | 16.25 |
| 6 laborers dumping, switching, and breaking, at ₱0.65 | 3.90 |
| 1 watchman, at ₱0.65 | .65 |
| 1 engineer | 2.50 |
| 1 fireman | .75 |
| 400 pounds coal | 7.00 |
| Oil | .40 |
| Total cost | 35.85 |

Therefore 192.96 kilometer meters cost ₱35.85; 1 kilometer meters cost ₱0.19; or 1 cubic meter ready to spread cost ₱0.89.

In the above tables no account was taken of depreciation charges, but even allowing 20 per cent depreciation on the locomotive and 3 per cent on money invested the amount per kilometer meter is only increased by ₱0.02, therefore total cost per kilometer meter = ₱0.21.

A comparison of the above tables shows a saving of ₱1.34 per meter in place in favor of the locomotive, and the locomotive delivers nearly three times as much rock in the same time as hand power.

This particular engine is a Koppel locomotive, 20 horsepower, 750 millimeters gauge, with 4 wheels coupled. Empty it weighs 4.5 tons; in working order 5.65 tons. It has a copper fire box, central lubrication, one injector, and one steam pump for the alimentation of the boiler. The diameter of its cylinders is 145 millimeters, diameter wheels 550 millimeters, stroke 260 millimeters. It has a tractive force on the coupling of 720 kilos.

While the smallest curve it is designed to go around is 10 meters, it is actually making one of only 6.5 meters radius.

An excellent feature of this engine is that it has no saddle tank, but its tank sets low between the wheels, consequently its center of gravity is low, an assurance for stability on poor track.

In the construction of the Burauen–Dulag Road, 18 kilometers long, 920 cubic meters are required for each kilometer or 16,560 cubic meters for the entire road, with an average haul of 3.5 Km.= 57,960 km. m.³.

Hand power unit cost = ₱0.46 or total cost for transportation = (57,960 x 0.46) = 26,661.60.

Locomotive power unit cost = ₱0.19 or total cost for transportation = (57,960 × ₱0.19) = ₱11,012.40 representing a saving of ₱15,649.20.

Deducting from this saving (original cost of locomotive ₱4,677.60 +10 per cent repair cost ₱467.76) = ₱5,145.36 leaves a balance of ₱10,503.84.

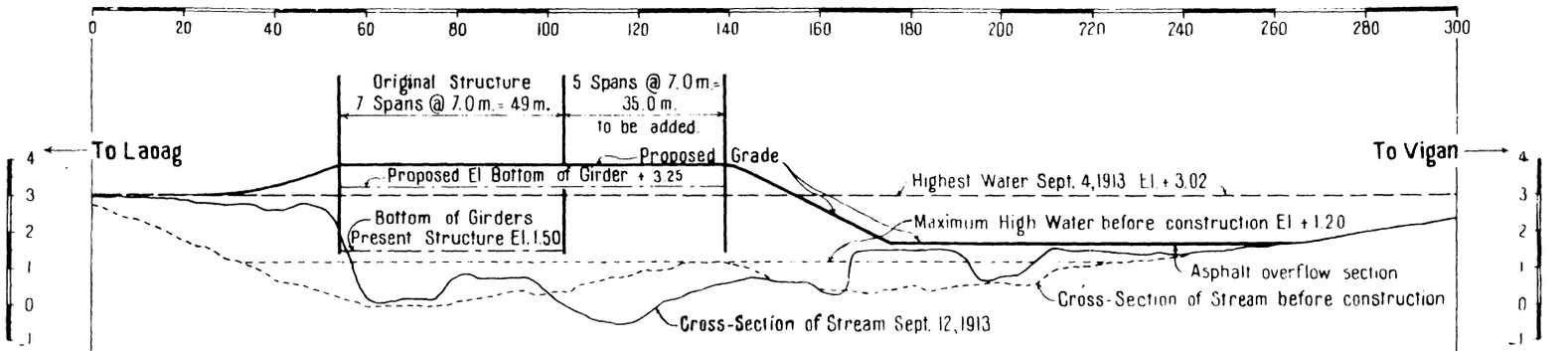
From May 21 to September 30, 12,665:10 km. m³. were hauled, representing by October 1, 1913, a saving of ₱3,419.60.

[1] High cost caused by adverse grade all the way from quarry to kilometer 42.9, making 3 or 4 men to a car necessary.

# DAMAGES TO BICAL, LAPOG, AND CABUGAO REINFORCED-CONCRETE PILE-BENT BRIDGES, PROVINCE OF ILOCOS SUR, DURING BAGUIO OF SEPTEMBER 3 AND 4, 1913.

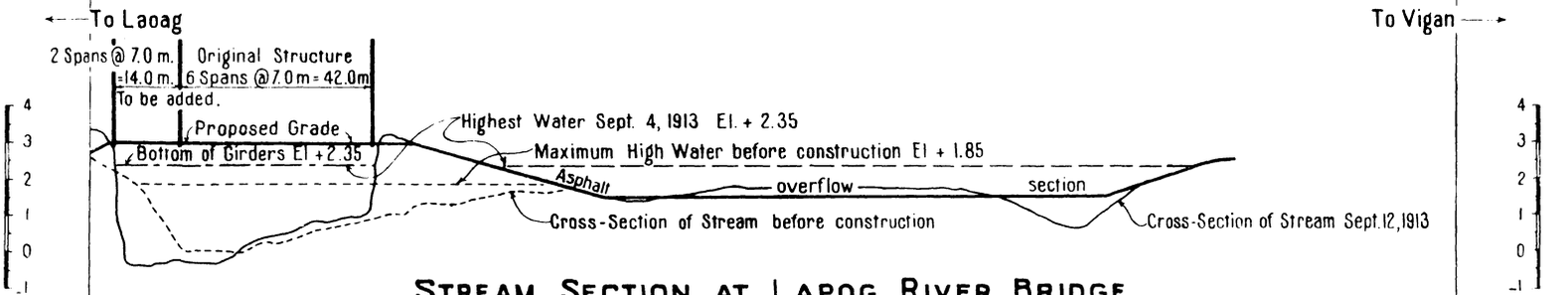
By D. E. HENRY, Member American Society of Engineering Contractors, Member Philippine Society of Engineers.

The advent of reinforced-concrete pile bridge construction in the Philippines has made possible the bridging of rivers heretofore shunned.



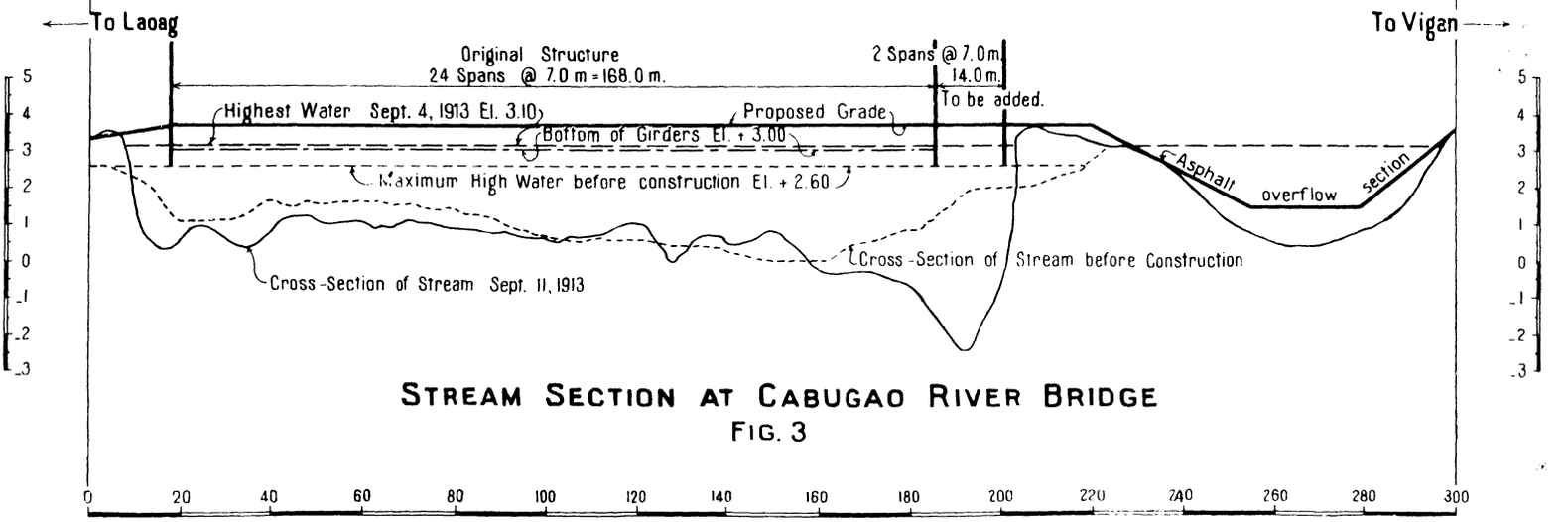

STREAM SECTION AT BICAL RIVER BRIDGE

FIG. 1




STREAM SECTION AT LAPOG RIVER BRIDGE

FIG. 2




STREAM SECTION AT CABUGAO RIVER BRIDGE

FIG. 3

Coming within this category are those streams which have their source in the mountains and which during heavy baguios are turned into river torrents rising to heights of 50 to 100 feet within a very short period. This immense wall of water emerging into the coastal plain at a high velocity is more than the natural stream bed can carry, often resulting in an overflow for 100 meters on either side of the stream section and in some instances after floods recede forming an entirely new channel. This has demonstrated the inadvisability of trying to confine such streams to the limits of the waterway area of a structure through high embankments built out from each approach and extending to higher ground. The bridge seat is therefore located well above known high water, and if low ground is found on one or both approaches, an overflow section, or sections as the case may be, are constructed from 1 to 1½ meters lower than clearance elevation of the bridge and extending to a point where high-water elevation intersects higher ground. Such overflow section should be either concrete or macadam with asphalt surface, slopes to be constructed of same material. The bridge designs for Bical, Lapog, and Cabugao were decided upon by engineers of the Bureau in 1911. Surveys and data sheets were sent in during the same year and plans prepared by the bridge divisio early in 1912. Same were advertised and a contract entered into with Allen & James, contractors. Work was started late in 1912 and the contract completed August, 1913, involving an expenditure of ₱77,806, which includes the Sinait bridge not taken up in this article, a total of 287 lineal meters of bridge. Figures 1, 2, 3 show profile of center line, and high water as obtained previous to construction; also the high-water elevation obtained during flood of September 3 and

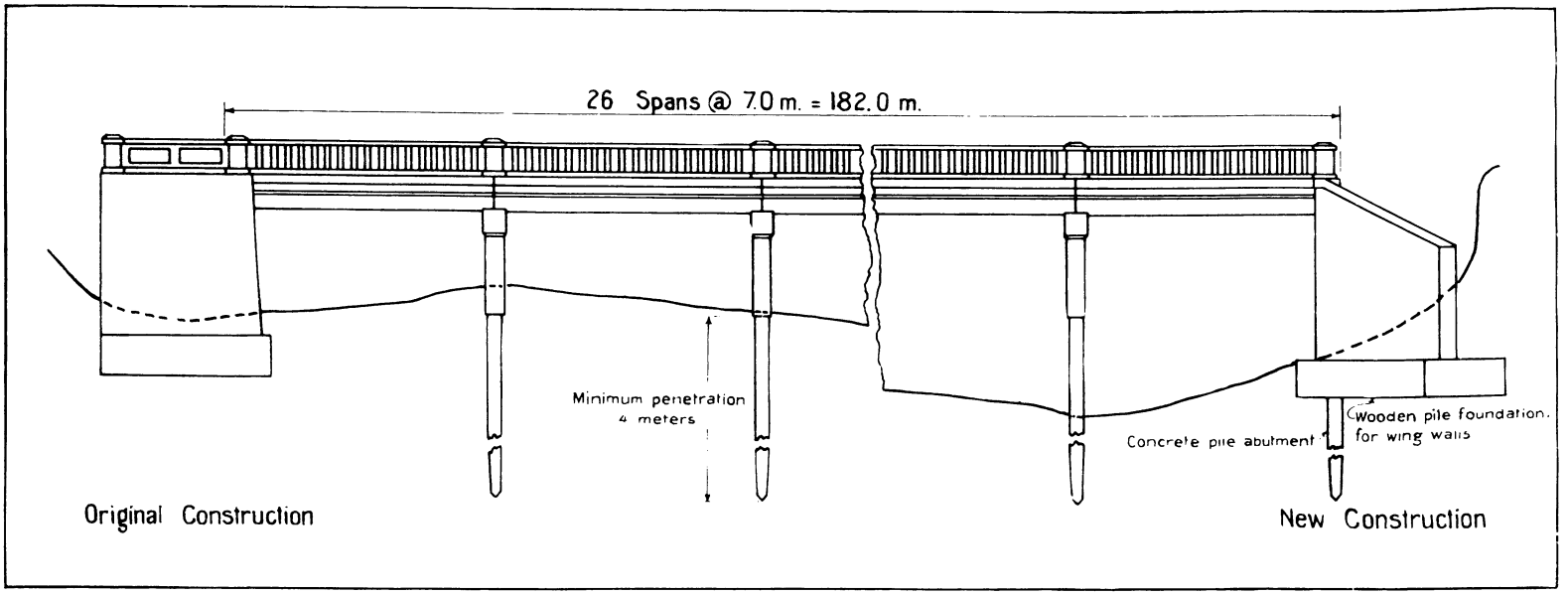



Fig. 4. Cabugao Bridge.

4, 1913, which destroyed one abutment of each bridge. The overflow section is shown in each instance located on south end of bridge. The grade line shows elevation to which roadway on the overflow sections will be constructed. Figure 4 shows in elevation original construction of one end of Cabugao bridge which was not on pile foundation, and also an elevation of concrete pile abutment which will replace the destroyed abutment. A comparison can be made from these two elevations. It is presupposed that scouring will take place in these stream beds and the depth to which piles are driven, 5 to 7 meters below low water, insures their permanency and with the same construction for the ends of the bridge possible future damage will be eliminated. Figures 5, 6, and 7 show the damaged Bical, Lapog, and Cabugao bridges. The May baguio did no scouring nor damage to any of these bridges. The baguio of

Fig. 5. South (Vigan) end of Bicol Bridge; one span lost.

Fig. 6. Overflow approach to Lapog Bridge.

September 3 and 4, 1913, scoured behind the south abutment of Bical bridge, causing it to fall back, tearing girders and handrails loose from the first pile bent. The crest of the flood passed over the top of the handrail, the only data available on previous high water having been secured from old residents and proved erroneous. The design of the bridge called for bridging only about $\frac{3}{5}$ of the distance between the old banks, as it was estimated a certain amount of scour would take place thereby providing a larger waterway.

The north abutment of Lapog bridge fell back carrying with it the first span. After the flood an old indigo vat was exposed in the river bed just down stream from the abutment, and a large tree 3 feet in diameter lodged in the lower side of the first span. These obstructions evidently aided in starting scour along the bank and behind the abutment. The approach to the south end of the bridge was damaged very little. However, about 100 meters south, as shown in figure 6, a large body of water passed over the road and at one point scoured out a channel 2 meters deep and 15 meters wide.

The Cabugao south abutment settled on the upstream side at an angle of about 30°. The first pile bent cap dips at an angle of about 5° upstream. The girders and handrails of the first bent were damaged very little. The baguio of July 29 and 30 scoured 1.30 meters below the bottom of the abutment which later failed. The district engineer stopped traffic and placed a wall of rock along the face of abutment and filled up the entire scour under the abutment and to a height of 1 meter above the river bed in its front and along its sides. Had more elaborate preparations been made at this time, the baguio of August 15 and 16 would in all probability have undermined the abutment sufficiently to destroy it. The final and heaviest baguio of September 3 and 4 scoured behind the abutment and caused its failure. This depth of scour, however, was less by 1.20 meters than deepest scour of July 29 and 30, showing that the protection work done after the July baguio was effective. Practically the same may be said of the north abutment. The approach fill was taken out and scour occured around the foundation of the abutment. The same protection work was done here after the July baguio as was done on the south abutment. The force of the water not being so great no damage resulted to this abutment in the baguio of September 3 and 4.

Fig. 7. South (Vigan) end of Cabugao Bridge.

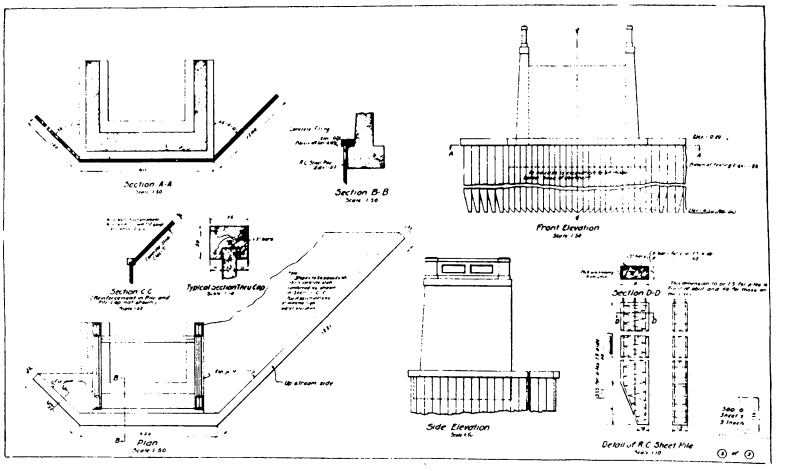



Fig. 8. Protection of north (Laoag) abutments not damaged by floods.

The results of this flood made it imperative to immediately replace the damaged ends and increase the length of each bridge. Revised plans were made replacing one span each on Bical and Lapog and two spans on Cabugao, adding 5 new spans to Bical—2 to Lapog and 2 to Cabugao—protecting the three remaining abutments as shown in figure 8, and raising the Bical bridge seat 1.75 meters. The total cost of the new work will be ₱49,625.75, while the value of the damaged part of these structures does not exceed ₱8,000. Had the six abutments been originally made entirely secure it would have required an additional expenditure of approximately ₱39,000.

## A RESULT OF POOR INSPECTION.

Due to insufficient inspection on the construction of the Malomoc bridge, Province of Cavite, the work was so carelessly done by the contractors that repairs are necessary at this early date. This bridge is a 12-meter span reinforced-concrete arch located on the Binacayan–Kawit Road, and was built under contract in 1909. The structure as it now appears is an unsightly piece of work, the noticeable defects being as follows:

1. The reinforcing bars in the balustrade and outside intrados line of the arch ring are exposed to view in a number of places, and the steel shows effects of having rusted considerably.

2. In other parts of the balustrade cracks follow the lines of the bars, admitting moisture, and exposing the steel to corrosion. Were this not remedied at once, the increase in volume of the steel consequent to its oxidation would cause the concrete to spall.

3. The concrete in the intrados of the arch ring is porous and has fallen away in places. This is especially noticeable at the location of the outside line of intrados bars, where pockets 3 inches and more in depth are to be found which extend over approximately three-quarters of the length of the intrados.

4. The end post caps of the balustrade were plastered over. This is noticeable in the nonuniform appearance and in the hollow sound when lightly tapped.

5. The alignment of the balustrade is bad and wavy lines are much in evidence.

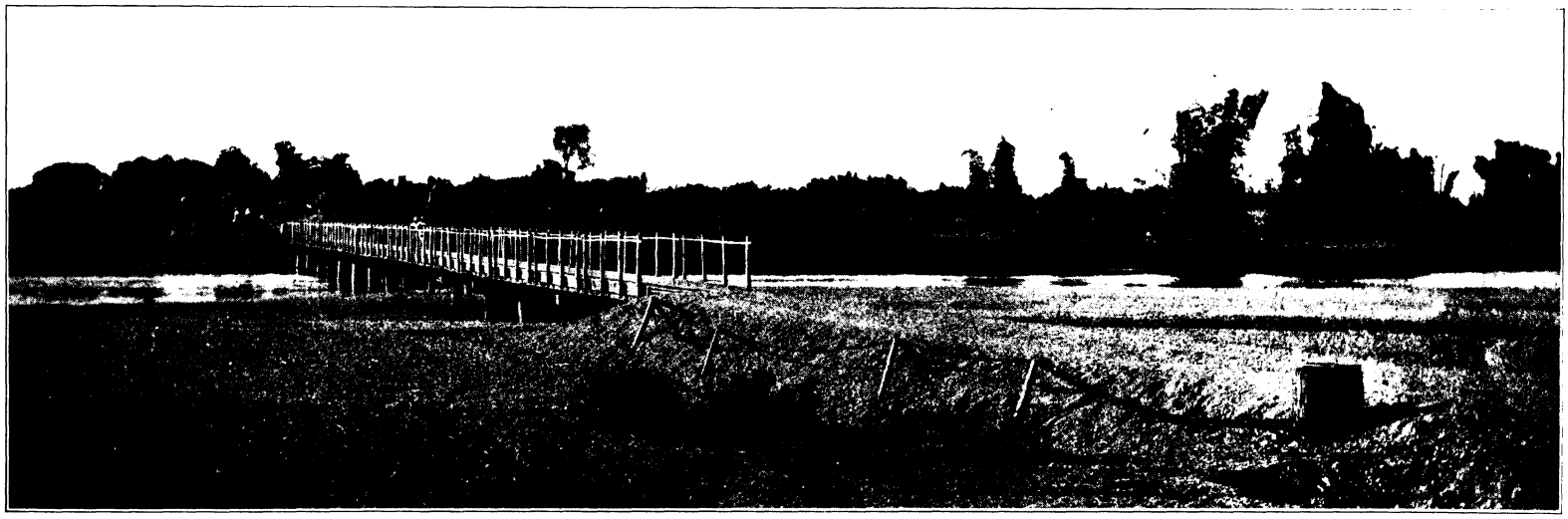
The first and second mentioned defects are due to the steel not having been securely fastened in the position called for by the specifications. The specifications for this work, state in part: "Furthermore, the center line of any bar shall not come closer than two diameters or less than one and one-half inches to any concrete surface * * *," and "all steel shall be held in place to true alignment by means of wire staples driven into the forms, pegs, or some other efficient device." In accordance with these, the bars should have had a minimum covering of 1½ inches. As the work was carried out the balustrade bars in places had a covering in many places of ⅛ inch.

The pockets in the arch ring are due either to there having been used an insufficient amount of mortar for filling the voids in the coarse aggregate, to leaky forms, or to the concrete not having been properly spaded and worked around the reinforcement.

It is clearly evident that these defects are due to careless workmanship made possible by poor inspection. It is only fair to state, however, that at the time this bridge was built, the district engineer had charge of several widely separated provinces, viz, Cavite, Bataan, Zambales, Mindoro, Capiz, and Antique, and as transportation facilities were poor it was often impossible for him to give his personal attention to more than a comparatively small number of the projects under construction in the various provinces of his district. Consequently he had to rely to a great extent on his inspectors, often without being able to pass upon their reliability before it was too late and the damage done. Under the present organization of the Bureau, with a district engineer in each province, and with improved facilities of transportation, the engineer is able to inspect work at frequent intervals, leaving no excuse for this class of work at the present day.

## DEVELOPMENT OF THE COLLAPSIBLE BRIDGE.

In the January 1, 1913, issue of the Quarterly Bulletin there appeared an article entitled "A Collapsible Bridge at Mangaldan, Pangasinan," by W. C. West, district engineer of Pangasinan.



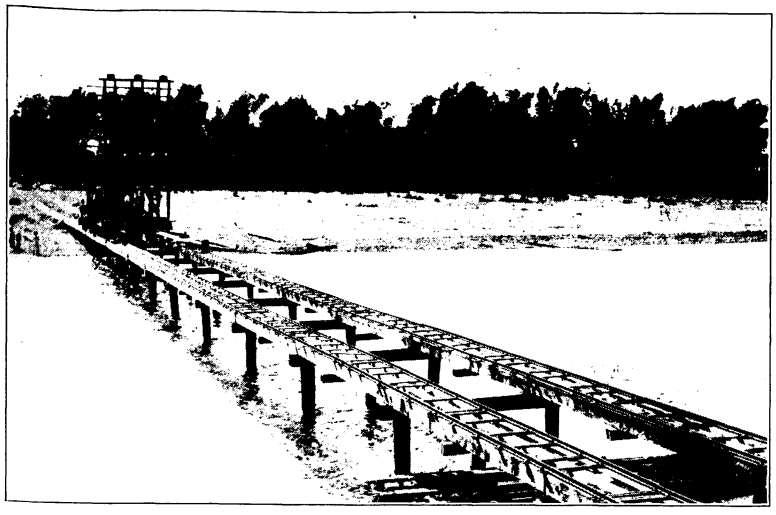
Collapsible bridge, Gapan, Nueva Ecija, showing anchor.

The bridge described was installed as an experiment to meet a condition that has always existed in the Philippines, a condition that the Spaniards were unable to meet successfully—that of providing quick, safe, and economical transportation at all times, except under extreme flood conditions, across wide overflow rivers; carrying just enough water at low stage to be unfordable; such large quantities of brush and trees during flood periods as to wreck concrete structures; and to be prohibitive in cost for permanent structures at the present stage of the country's development.

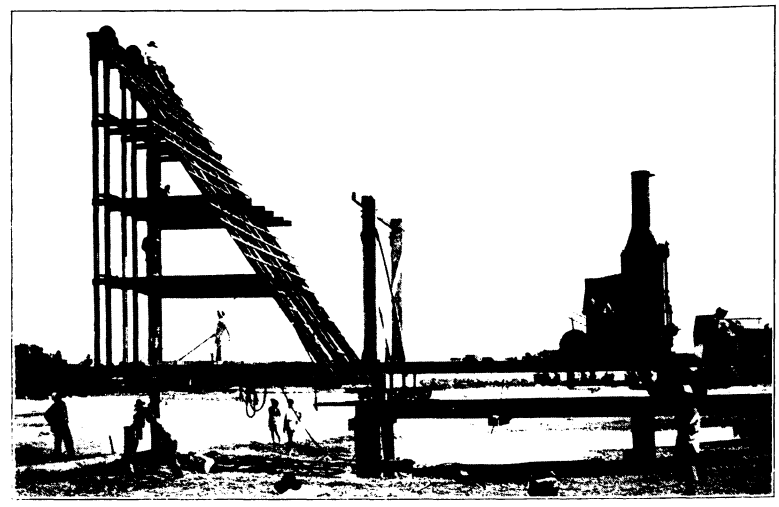
The several bridges thus constructed have proved so successful in operation, under the very worst conditions, that the Bureau has adopted a standard design for a 10-ton road roller, which is applicable to all road crossings influenced by storm conditions, where the range between low and high water is large, and where the river cannot be forded at low-water stage.

A collapsible bridge constructed in accordance with these standard plans that merits a brief description has recently been completed over the Peñaranda River at Gapan, Nueva Ecija Province.

This river has a flood width of 500 meters (1,640 feet) and a permanent bridge for this location would cost approximately ₱160,000 against ₱7,056 for the collapsible bridge constructed. As the river in this vicinity has no fixed or permanent banks there is every danger that the permanent bridge, if constructed, might be left high and dry, while the stream bed might have a new location a kilometer or



Collapsible bridge over the Rio Grande River at Cabanatuan, Nueva Ecija, showing stringer units in place that take the wheeled traffic.



Three-lead pile driver used on Gapan and Cabanatuan collapsible bridges in Nueva Ecija Province.

more distant. Therefore financial considerations dictated the collapsible bridge, which is hereafter described, as the most effective solution for the above described river.

The length of bridge constructed for this site is 97.6 meters (320 feet), composed of sixteen 6.1-meter (20-foot) spans. The width of this bridge between guard rails is 2.2 meters (7 feet 2 inches) with a minimum gauage of runway of 0.97 meters (3 feet 2 inches) which gives a 0.61-meter (2-foot) runway width on each longitudinal set of stringers, besides a 0.76-meter (2 feet 6 inches) timber deck walk along the bridge center.

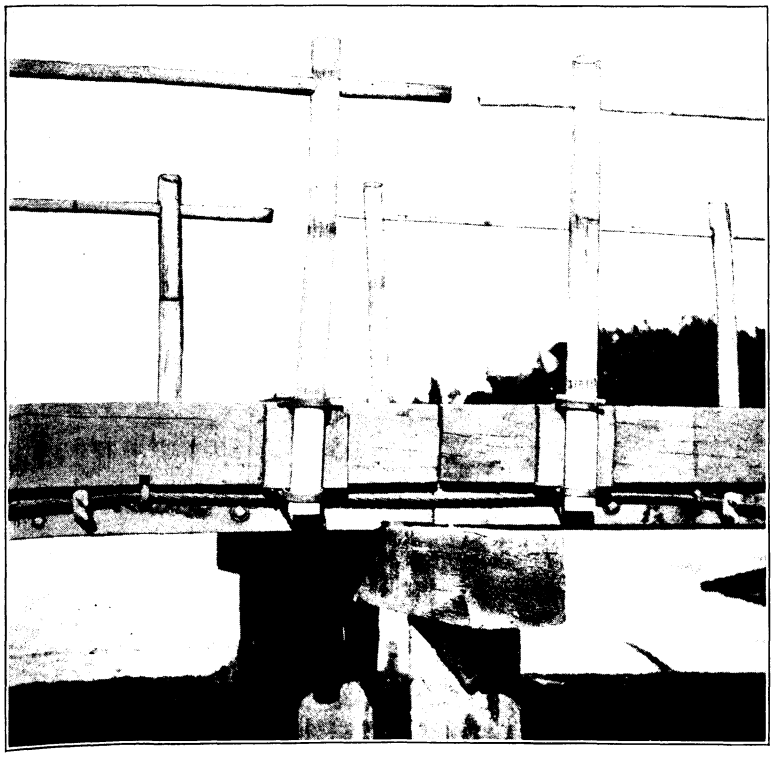
The low-water elevation for this river was assumed at 24.84 meters (81.48 feet) and the elevation of high water 28.7 meters (94.14 feet).

The pile bents each consist of three piles on 1.37-meter (4.5-foot) centers, braced with two 5 by 25 centimeters by 3.66 meters (2 by 10 inches by 12 feet) diagonal timber, which are also bolted to the caps. The piles were driven until the penetration of base of pile reached the minimum elevation of 19.8 meters (64.9 feet), while the cut off elevation is 26.15 meters (85.8 feet).

The 30 by 30 centimeters by 3.66 meters (12 by 12 inches by 12 feet) caps on which the deck spans rest are drift bolted to the pile tops and also bolted to the pile bent diagonals as shown above.

The collapsible deck construction consists of three units, two sets of longitudinal stringers, and a deck span between each unit having a separate cable connection to shore anchors. The stringer units are on 1.58-meter (5 foot 2 inch) centers and each consists of three timbers bolted together, the two outside timbers in each unit being 25 by 25 centimeters by 6.1 meters (10 by 10 inches by 20 feet), while the inside timber is 20 by 25 centimeters by 6.1 meters (8 by 10 inches by 20 feet), with a 5 by 25 centimeter by 6.1 meter (2 by 10 inch by 20 foot) molave or ipil strip nailed on top as a wearing surface for wheeled traffic.

The central deck consists of 5 by 20 by 97 centimeter (2 by 8 inch by 3 foot 2 inch) transversal planks resting on 5 by 10 centimeters by 3 meters (2 by 4 inches by 10 feet) cleats, nailed and bolted to inside of the stringer units at an elevation so that the deck span is flush



Collapsible bridge, Gapan, Nueva Ecija, showing method of fastening and anchoring deck spans to cable.

Collapsible bridge over Rio Grande River at Cabanatuan, Nueva Ecija.

with the top of stringer units. Each span consists of two 3-meter (10-foot) units, and the planks of each unit are held together by means of 5 by 10 centimeters by 3 meters (2 by 4 inches by 10 feet) diagonal underneath braces, and two 5 by 10 centimeters by 3 meters (2 by 4 inches by 10 feet) top battens that also form the minimum gauge and act as inside guard for the wheeled traffic.

Each stringer unit is also fitted with an outside guardrail to which are fastened the bamboo posts for handrail, four posts to each stringer unit of the span.

The posts of the bamboo handrail fit loosely into saddle straps and sockets attached to the outside guardrail in order that this rail can go out quickly during collapse of deck units.

Each one of the three bridge units is anchored to the shore by a separate steel cable, which holds together the different spans by means of a specially designed changeable hook bolt for stringer units, and U bolts for deck units. Crosby clips are fastened to these cables in such a manner as to hold each span at its allotted place on the cable as the deck units swing inward to the banks during collapse of bridge. For a bridge less than 30.5 meters (100 feet) a 1.27-centimeter ($\frac{1}{2}$-inch) cable; for 30.5 meters (100 feet) to 61 meters (200 feet) a 1.59-centimeter ($\frac{5}{8}$-inch) cable; for 61 meters (200 feet) to 91.4 meters (300 feet) a 1.9-centimeter ($\frac{3}{4}$-inch) cable; and from 91.4 meters (300 feet) to 122 meters (400 feet) a 2.54-centimeter (1-inch) cable is used for holding the stringer units, with a smaller cable for the lighter center deck unit.

As a rule, the bridge during collapse is designed to break into two sections anchored to opposite sides of the river, but conditions sometimes exist, such as a high bank on one side as at Gapan, where the bridge forms only one section and in collapse swings to the low side of the river.

The shore anchors usually consist of one or more pile clusters around which the cables are securely fastened with "dogs" and some form of cable clip.

In replacing these deck span units after collapse, a light traveling crane running on the bents is used to lift the units in place again.

On the construction of the Gapan bridge considerable ingenuity was shown by the contractor, Marion E. Martin, in designing the pile-driving plant.

On each of the stringer units as constructed was laid a contractor's portable railway on a fixed gauge. On these tracks a traveling pile driver mounted on four gravel car trucks was operated.

The pile driver construction consisted of three 25 by 25 centimeter (10 by 10 inch) longitudinal timbers bolted on top of two 30 by 30 centimeter (12 by 12 inch) transversal timbers, one resting on each set of trucks. The cantilever section of 6.7 meters (22 feet) extends forward from the first set of trucks and was formed of 5 by 25 centimeter (2 by 10 inch) timbers on edge and bolted as an extension to the 25 by 25 centimeter (10 by 10 inch) timbers of pile drivers base.

The two 5 by 25 centimeter (2 by 16 inch) of each cantilever set diverged one from the other sufficiently to form the openings for the pile driver leads of which there were three sets, spaced so that, the pile driver once set, the three piles for a bent could be driven by only shifting of the 1,000-kilo (2,200-pound) hammer and line from one lead to the next.

A 20 by 30 centimeter (8 by 12 inch) transversal timber with the 30-centimeter (12-inch) side flat, just abaft the leads, carried the 5 by 25-centimeter (2 by 10-inch) timbers of the cantilever frame, this 20 by 30-centimeter (8 by 12-inch) timber being in turn supported by a truss which consisted of a 30 by 30 centimeter (12-inch) A frame erected over the forward trucks which carried two 1.9-centimeter ($\frac{3}{4}$-inch) truss rods, the other of which were anchored to the 30 by 30 centimeter (12 by 12 inch) timber that rested on the rear trucks.

A 30-horsepower Lidgerwood boiler with a double drum 20-horsepower engine was mounted on the frame over the rear trucks. This weight supported the cantilever section of driver.

With this plant it was possible to drive and cap two bents a day and the results secured in operation were quite satisfactory.

An improvement in the pile driver arrangement for this work that has had a practical application which would allow for same cantilever effect and faster work is hereby suggested:

On the top of a 25 by 25 centimeter (10 by 10 inch) or 30 by 30-centimeter (12 by 12-inch) timber square frame, held together by iron tie rods and wooden corner braces, fasten a circle made from a 9.1-meter (30-foot) rail. To each of the two sides of these frames, parallel to the center line of bridge center, can be attached a pair of double flanged wheels to run on a wide gauge track, or this frame may be mounted on two sets of trucks same as shown above.

In the center of the wooden frame bolt the male part of a derrick footing, while on the bottom of any pile driver frame the female part of the derrick footing should be fitted, also for small steel rollers fixed on bearings on the bottom of the pile driver hounds on the same radius of the rail from center pivoting arrangement.

To the bottom of the square frame is bolted a 20 by 20 centimeter (8 by 8 inch) timber extending out about 10 feet on one side at right angles to the center line of bridge. At each side of the outside end of this timber is a hook for a tackle attachment.

A hook is also fastened at each end of the pile driver hounds for the working end of the tackle. By this arrangement the pile driver can turn in a circle of 270° or more, the tackle lines being taken to the engine niggerhead for operation.

A truss similar to one shown above may be used to stiffen the pile driver. The location of hoisting boiler and engine must be calculated to take care of the weight of the cantilever section, and the load to be handled.

The pile driver can be advanced or moved back by pinch bars or by lines operated on the niggerhead with the fixed end to an anchor before or behind driver.

This pile driver is lighter, moves quickly and easily, requires no changing of hammer or lines, and has a record of eight-two-pile bents a day under harder conditions than prevailed on this project.

## ARTESIAN WELL DRILLING IN THE PHILIPPINE ISLANDS.

By J. W. VICKERS, Superintendent, Artesian Wells Division, Bureau of Public Works.

### ORIGIN OF THE WORD "ARTESIAN" AND THE CORRECT USE OF THE TERM "ARTESIAN WELL."

The process of obtaining water and testing mineral deposits by sinking wells of small diameter has been practiced in various parts of the world for many centuries. In Europe, however, it was first employed in the Province of Artois, in the north of France, now the Department of Pas de Calais, and a deep bored well in the grounds of a former Dominican convent at Lillers in that province, which was completed during the year 1126, has flowed continuously since that date. The word "artesian" as applied to wells was, therefore, derived from the name "Artois," the former name of a French province where the process was first employed by Europeans.

The term "artesian well," however, while originally applied to flowing wells only, is now generally used, especially in the United States, as applying to any deep bored well, whether the water flows naturally or is raised to the surface by means of a pump.

Water from deep bored wells may, therefore, be properly classed as artesian and subartesian, and the wells as flowing and nonflowing.

Artesian water is under sufficient natural pressure to cause it to flow from the well at or above the surface of the ground.

Subartesian water is under natural pressure which causes it to rise to a considerable height in the well, but is not sufficient to force it to or above the surface of the ground.

### HISTORY OF WELL DRILLING.

The modern method of percussion drilling is the adaptation of steam power to an improved type of primitive outfit which has been in use in China for ages, as indicated by the many references to well-drilling machinery found in ancient Chinese writings, and the fact that some of these outfits are in use in western China at the present time. As China is a country prolific in inventions, it is not surprising

to find that Chinese engineers devised centuries ago a churn drill which, in principle, was the same as the ordinary percussion drill used to-day. Although the Chinese, urged by the necessity of obtaining water from deep wells, especially in the extensive arid districts, reduced well drilling to a science, they did not advance beyond the most primitive stage in the construction of well-drilling machinery; and for the past hundred years, during which time the most remarkable mechanical development has been witnessed, particularly in the United States, they have made but few improvements in their apparatus.

### THE BEGINNING OF SCIENTIFIC WELL DRILLING IN EUROPE.

Well drilling along scientific lines was commenced in Europe during the early part of the nineteenth century, one of the earliest instances of successful deep drilling for a municipal water supply being the well at Grenelle, France. This well was completed in 1841, after seven years of incessant labor. It was sunk to a depth of 1,798 feet and for several years had the distinction of being the deepest well in the world.

### EARLY HISTORY OF WELL DRILLING IN THE UNITED STATES.

One of the first deep wells drilled in the United States was at Charleston, South Carolina, and, during the period from 1850 to 1860, others were sunk at St. Louis and Bonette's Mill, Missouri, and Louisville, Kentucky.

The remarkable mechanical development in well-drilling machinery since 1860, however, has been due principally to the discovery of oil and gas in the United States, and to the development of the oil fields in Pennsylvania and other States. Deep wells can now be sunk at a relatively small cost; and as their advantages over the old-style dug wells are everywhere recognized, they have come into general use in practically every part of the United States. The fact that deep drilled wells, if properly lined with iron or steel pipe, are seldom contaminated by surface matter, has brought them into favor as sources of supply for small municipalities in many parts of the world; and in the United States, Europe, and Australia even large cities are sometimes supplied with water from artesian wells. In Texas, New Mexico, and California many wells have been drilled to supply water for irrigation purposes, but owing to the consequent heavy drain on the underground supply in these districts, the normal level to which the water at first rose is gradually becoming lower; and in some instances, wells that originally supplied water in large volume have ceased to flow, and are now used as pumping wells. This matter has been brought to the attention of the legislative bodies in the States referred to, and laws have been passed regulating the drilling of wells, restricting the number that may be drilled in certain areas, and providing in other ways for the conservation of this, one of the most valuable of natural resources.

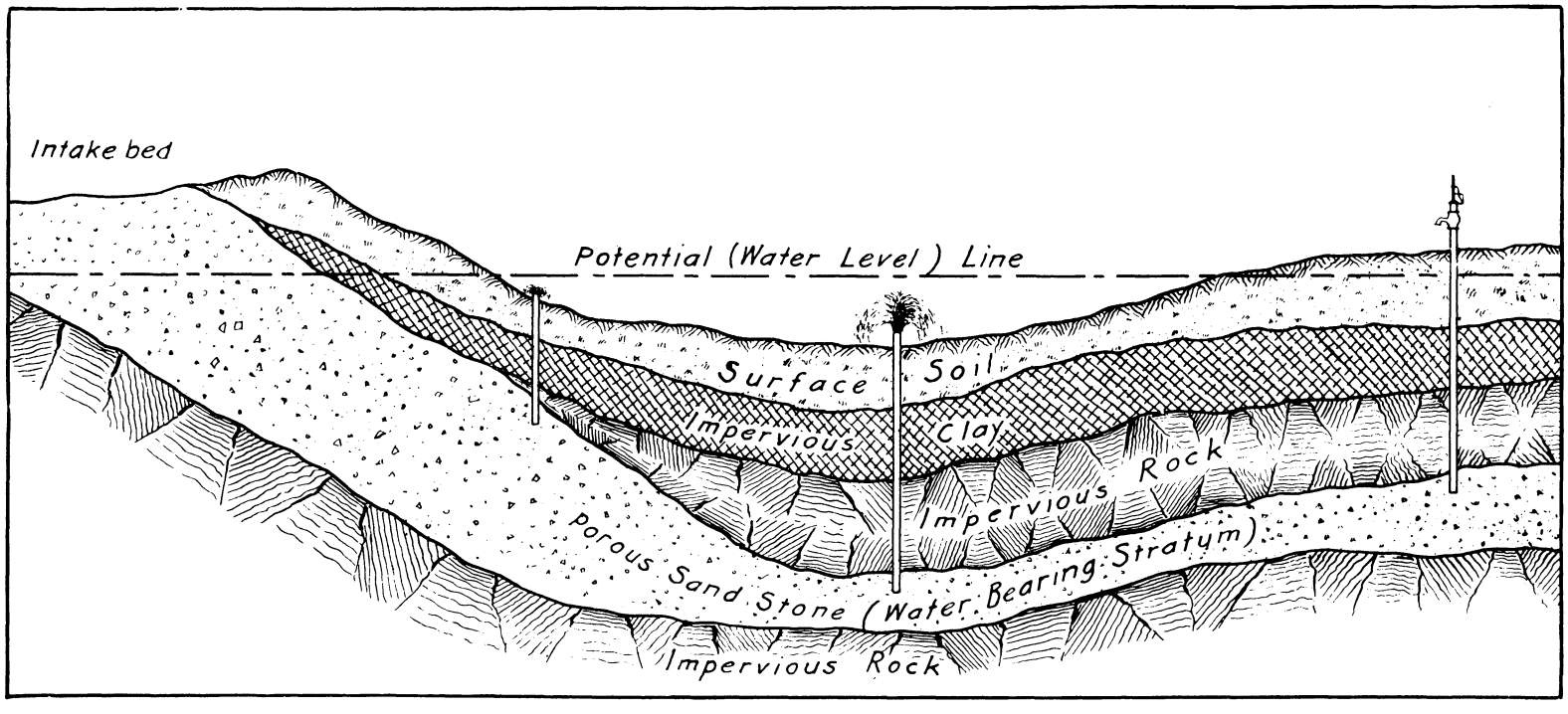



Plate showing strata.

*Fishing.*—The history of this well supplies the first authoritative record of what is now called a "fishing job"—that is, the process of recovering parts of the drill left in the bore by accidental breakage or separating of joints. When the drilling had progressed to a depth of 800 feet, the bit broke loose from the upper section of the drill while in operation, and the most skilful men available at that time exerted their ingenuity to the utmost for several months in an effort to recover the bit. They finally succeeded, and the work of drilling was continued to completion without further serious mishap.

The success attending the completion of this well was followed by the commencing of the famous Passy well of Paris, which was sunk to a depth of 1,923 feet. The diameter of the Passy well was 2 feet and 4 inches. The well was completed in 1857, and the volume of water developed was so great that it delivered 5,500,000 gallons daily at an elevation of 54 feet above ground surface.

Another remarkable well was drilled at La Chapelle, the diameter in this case being 5 feet and 6 inches, and the depth 1,000 feet. The drill used, as its diameter would indicate, was a clumsy, cumbersome affair, weighing 4 tons, and was operated by steam power so arranged as to deliver 15 to 22 blows per minute.

### WORLD RECORDS OF DEEP WELLS.

The deepest well in the world was drilled in upper Silesia, Germany, in an effort to locate bodies of coal which the geologists believed to exist there. A diamond drill, 2.7 inches in diameter, was used, and the well was sunk to 6,572 feet, the greatest depth ever reached by drilling. Two gangs of operators, working twelve hours each per day, were employed; and the average rate of progress made was 12 feet per twenty-four hour day. The work was completed in eighteen months, at a cost of ₱37,000.

Manduriao artesian well, Iloilo.

Another remarkable well was sunk near Liepsic, Germany, by a coal-mining company exploring for coal. The diameter of this well was 11 inches at the surface and 1.3 inches at 5,750 feet, the depth at which drilling was discontinued. The average daily rate of progress was 4½ feet, and the cost of the work was ₱106,000.

The deepest well in the United States was drilled near West Elizabeth, Pennsylvania, by an oil syndicate for the purpose of testing the deep lying strata for oil or gas. The diameter was 8 inches at the surface and 5⅝ inches at 5,575 feet, the lowest point reached. This is the deepest well ever drilled with cable tools, and is also the third deepest in the world. Two coils of cable spliced together were used, the upper section being 2½ inches in diameter and 4,000 feet in length and the lower section 2 inches in diameter and 2,000 feet in length. A specially designed rig was used, as gear of more than ordinary strength was required to handle the heavy load of cable, which weighed more than 4 tons. The total cost of the work was ₱80,000.

### GOVERNMENT WELL DRILLING IN THE PHILIPPINES.

One of the most difficult problems presented to the American Government upon its inauguration in the Philippines was that of supplying pure drinking water for the numerous, thickly populated, small towns and their outlying barrios, probably 95 per cent of the entire population of the Islands outside of Manila being almost wholly dependent upon open surface wells and sluggish lowland streams for the daily supply. The use of water taken from these sources for drinking and domestic purposes was extremely dangerous, contaminated water being one of the most prolific producers of sickness and disease; and in many cases the deplorable health conditions found in practically all parts of the archipelago during the early days of American occupation were directly traceable to its use.

As the cost of constructing an adequate number of municipal water-supply systems, utilizing gravity line or pumping plant methods, was far in excess of funds available, it was finally decided early in 1904, if the results of experimental drilling provided for at that time should prove favorable, to relieve the situation by drilling at least one artesian well in each of the more important towns. A small well-drilling machine was accordingly purchased, and experimental work commenced by the Bureau of Engineering (now Bureau of Public Works). Work with this machine was continued until 1906, and it was demonstrated that artesian water could be obtained by drilling in several of the provinces. The demand for wells was most urgent and, to meet this demand, the purchase of two additional outfits by the Bureau of Public Works was authorized. Upon the arrival of these machines from the United States the artesian wells division of the Bureau of Public Works was organized, regular itineraries prepared, and systematic drilling commenced. The popularity of this work increased rapidly, and it soon became evident that the demand for municipal wells would necessitate a large increase in well-drilling equipment.

The cost of a sufficient number of machines of the deep-well type was in excess of the funds available at that time and the Insular Government met this demand for new equipment by designing and constructing several small hand-power outfits, known as "jet rigs." It was soon demonstrated that these outfits, owing to their simple design, could be operated to advantage by native workmen in localities where it was not necessary to drill to depths greater than 200 to 300 feet, and where no rock or difficult strata had to be penetrated; and for that reason they became very popular throughout the archi-

Artesian well in the town of Bauang, Batangas.

pelago. The demand for this class of equipment increased until 1911, when 45 jet rigs had been constructed and equipped for operation and practically every province, wherein they could be successfully operated, had been supplied with from one to five outfits. It was found, however, that in many localities the deep-well or steam-power rigs were necessary for successful operation, and the demand for wells in these localities was so insistent and increased to such an extent that additional equipment of this class was added from time to time, until 25 deep-well machines had been purchased. Funds for the operation of both jet and deep-well rigs were provided entirely by Insular appropriations until 1910; at this time a coöperative policy was adopted whereby one-third of the cost of drilling was borne by the provinces or municipalities for which the work was done and two-thirds by the Insular Government. The deep-well rigs were operated by the Bureau of Public Works as before, while many of the jet rigs remained under the supervision of provincial officials. This policy proved to be entirely satisfactory and is still being followed.

A large number of the wells drilled in the Islands have a natural flow, some of them supplying enormous quantities of water, notably, the famous gusher at Bayambang, Pangasinan, which supplies 1,000,000 gallons daily. The water from the latter is distributed

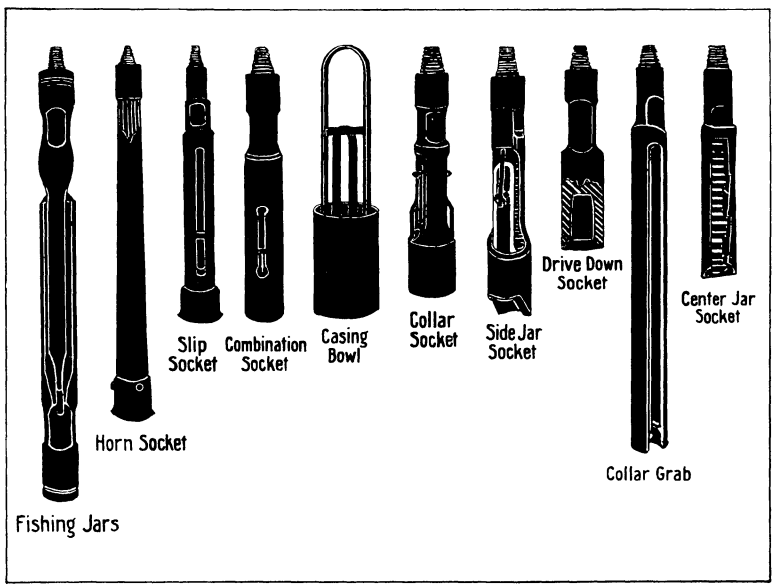



Plate 2.

through two main supply pipe lines, one leading to the military post at Camp Gregg, and the other to the town of Bayambang. In many of the provinces it is necessary to drill wells ranging from 600 to 800 feet in depth in order to obtain good water. In the town of Wright, Samar, good water was not encountered until a depth of 1,025 feet was reached, when flowing water of excellent quality was tapped. This well is the deepest in the Islands which supplies good water. A number of wells have been drilled to greater depths, however, but in every case except the one mentioned above salt water was encountered below 1,000 feet. The deepest well ever drilled in the Islands was located on the trade school grounds at Iloilo, and was sunk to a depth of 2,285 feet without encountering fresh water. An interesting feature in connection with some of the wells is the effect the ocean tide has upon the fresh-water flow, one remarkable instance being the well at Bauan, Batangas, drilled to a depth of 298 feet, which flows 250 gallons per minute 18 inches above the ground surface at high tide, and 50 gallons per minute at low tide at the same elevation; in other words, the flow at high tide indicates an increase of 400 per cent over the flow at low tide, notwithstanding the fact that analyses of water samples collected at both high and low tide give identical results and show the water to be potable and free from salt-water contamination. In the Provinces

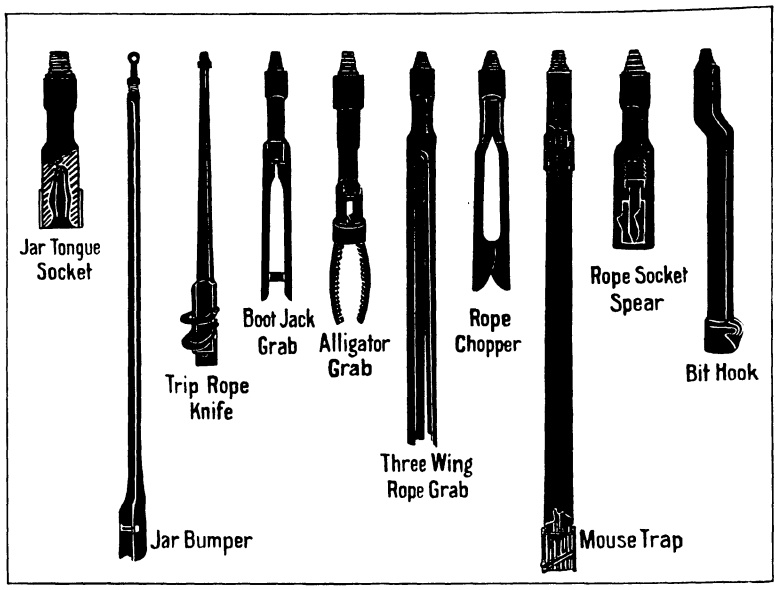



Plate 3.

of Bulacan, Pampanga, and Bataan, where a large number of wells have been completed, the waste water or overflow is in many cases utilized to irrigate small plots of rice land; but not more than two or three wells have been drilled solely for irrigation purposes.

PROGRESS IN WELL-DRILLING OPERATIONS SINCE 1906.

The progress made in well drilling since 1906 is shown in the following table of successful wells drilled during the fiscal years 1906 to 1913:

| Fiscal year— | With deep-well rigs. | With jet rigs. | Total. |
|---|---|---|---|
| 1906 | 3 | | 3 |
| 1907 | 12 | | 12 |
| 1908 | 9 | | 9 |
| 1909 | 12 | 112 | 124 |
| 1910 | 15 | 157 | 172 |
| 1911 | 17 | 199 | 216 |
| 1912 | 42 | 104 | 146 |
| 1913 | 92 | 54 | 146 |
| Total | 202 | 626 | 828 |

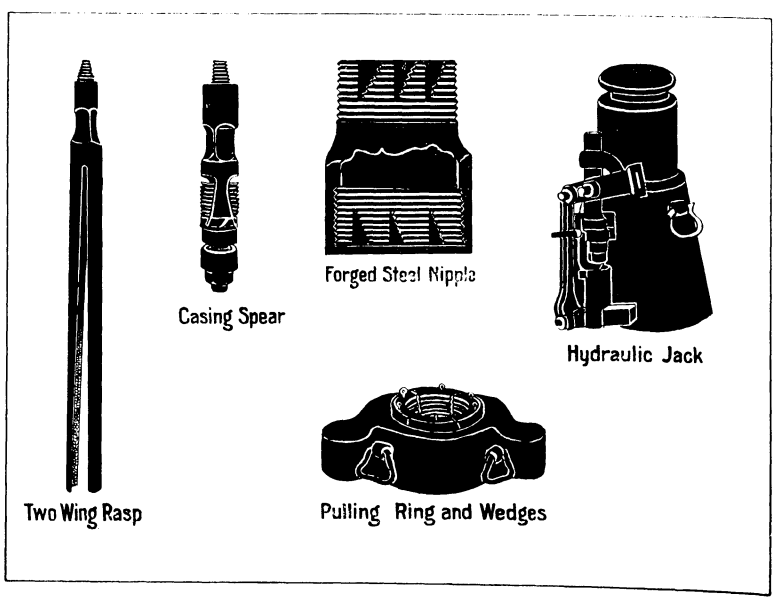
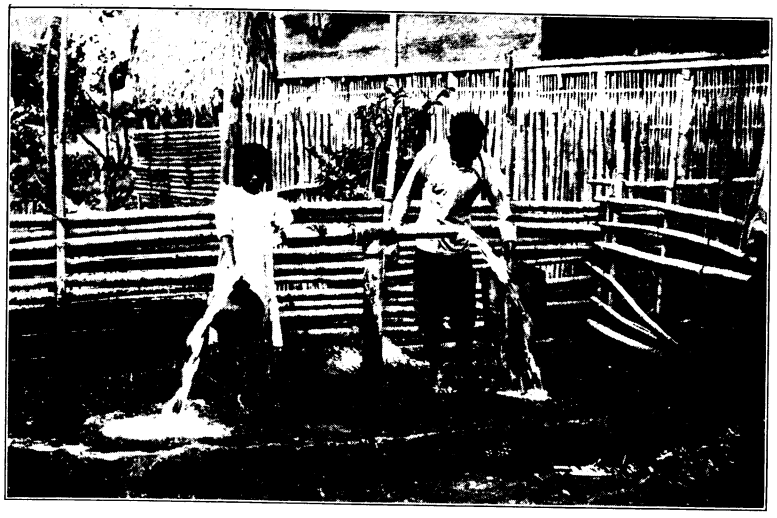



Plate 4.



Hermosa artesian well at town, Bataan.

San Roque artesian well at San Roque, Cavite.

It is estimated that 1,500,000 people (or more than one-sixth of the population of the Islands) are supplied with water from these wells.

IMPROVED HEALTH CONDITIONS.

Concerning the beneficial effect from the use of artesian-well water and the marked falling off in the death rate in localities where artesian wells have been drilled, the Director of Health has commented thereon in various papers, as follows:

In towns where artesian well water is almost exclusively used the death rate has fallen 50 per cent. These wells are being drilled as rapidly as possible, but there are many localities where they are impracticable, so that the question of how to make available for the people an unlimited and safe water supply exclusive of artesian well water must be considered one of our unsolved problems.

* * * * * * *

Hundreds of artesian wells have been bored throughout the Islands, and work is under way for the installation of many hundreds of others. Wherever the water from an approved well has been exclusively used by a community, the death rate has often dropped 50 per 1,000. In other words, in a town of, for instance, 3,000 inhabitants, there are now 150 less deaths annually than occurred before pure drinking water was furnished.

* * * * * * *

The progress made in the installation of artesian wells has been most gratifying. * * * The Legislature is constantly augmenting the appropriations for this purpose and for the fiscal year 1911 has voted ₱300,000 as against ₱105,000 for last year. There is a widespread interest throughout the Philippines with regard to artesian wells as can be testified to by members of the Assembly who are burdened by numerous petitions and voluminous correspondence from their constituents with regard to local wants.

WELL-DRILLING METHODS IN USE IN THE PHILIPPINE ISLANDS.

Well-drilling methods employed in the Philippine Islands may be divided into two classes: Percussion and hydraulic.

The percussion method is used extensively by both the Insular Government and military authorities, and by several local contractors.

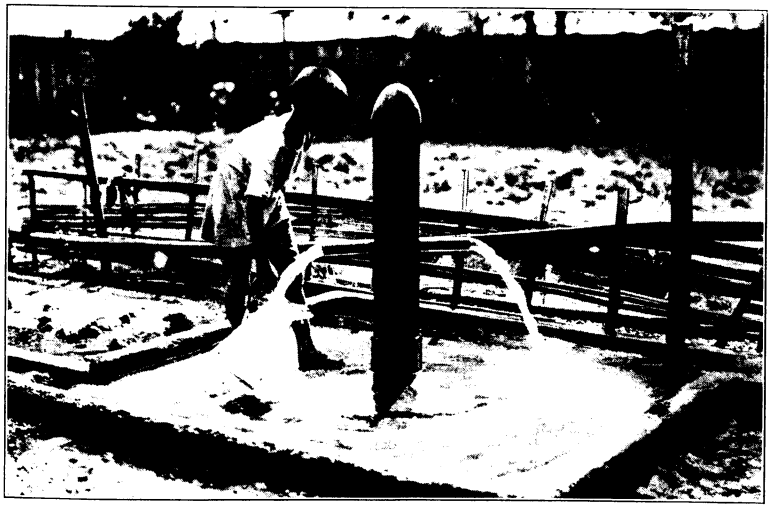
The hydraulic method is employed by the Insular Government, chiefly as an auxiliary to the percussion or cable-tool outfits.

The principle of percussion drilling is utilized in all standard and portable types of cable-tool outfits, and also in the pole-tool or Canadian rigs and the self-cleaning outfits. While these outfits are all recognized as distinct types, they differ only in their various arrangements for handling the drills, and not in the drilling operation itself.

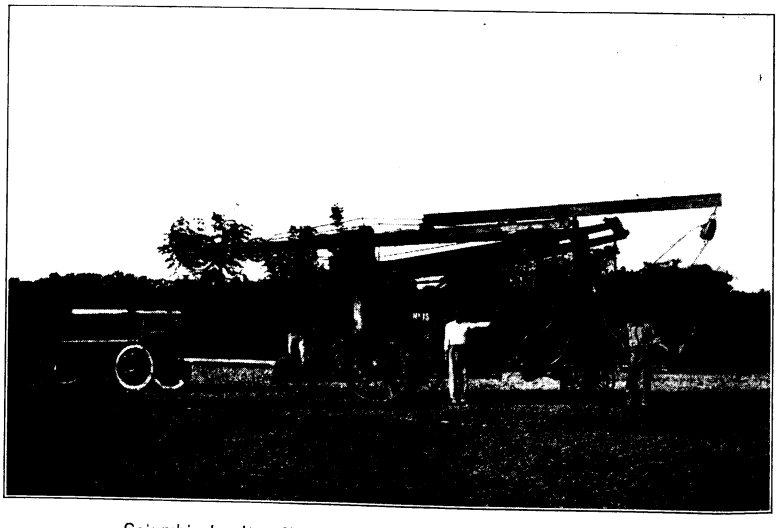
Practically all well drilling in the Archipelago is done with portable cable-tool rigs, but as a technical description in detail of the several styles of machines used would require considerable space, and would not, it is believed, be of special interest to persons outside of the trade, the writer has endeavored to give only a general idea of the methods employed, and by aid of the accompanying illustrations to make the meaning clear.

Portable rigs are, strictly speaking, modified types of the standard outfit, and are divided into two general classes—the traction, and the nontraction. They are built in compact form, on heavy, rigid frames, and are mounted on wheels in order that they may be readily moved from one location to another.

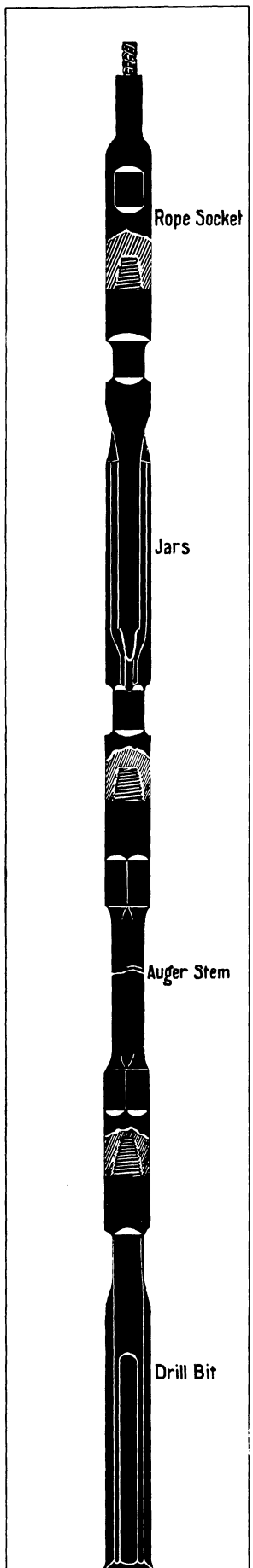
Steam engines and boilers, usually mounted on the frames of the machines, are used, the engines ranging in size from 10 to 20 horsepower, and the boilers from 12 to 25 horsepower, according to the capacity of the machine.



Baliwag artesian well at Calle Conzales, Baliuag, Bulacan.



Columbia traction No. 3 well rig at Antipolo, Rizal Province.




Complete "String" Of Drilling Tools

Plate 1.

The Insular Government machines vary in capacity from 1,000 feet to 2,500 feet when only cable tools are used; but by utilizing the hydraulic or rotary attachment as an auxiliary, the larger outfits are capable of drilling to 3,000 feet.

Although the expression of an opinion on the relative merits of the various kinds of machines in use would be obviously improper in this paper, the advantages of the traction over the nontraction types for provincial use are so marked that it is believed there can be no objection to the statement that drilling can be done more economically with the traction than with the nontraction; as, owing to the scarcity of work animals in many of the provinces, the cost of moving a nontraction outfit is usually high and the work requires considerable time, while the traction outfits can be moved by steam power in a comparatively short time.

The nontraction machine of 1,000 feet capacity is provided with a mast, or two-legged derrick, 50 feet in height; and the traction machine of the same capacity with a derrick 38 feet in height. In this respect the nontraction has a decided advantage over the traction, as the additional 12 feet of derrick height enables the operator of the nontraction machine to handle lines of pipe in longer sections than is permitted by the shorter derrick of the traction machine.

All percussion cable-tool outfits use a heavy jointed drill, called a string of tools, which varies in weight and length to suit the conditions under which it must be operated. The apparatus is so arranged that the tools, suspended by a cable, can be raised and dropped rapidly, causing the bit, which delivers a heavy blow on the rock at the end of each descending stroke, to pound it into fragments or "cuttings" small enough to be removed from the hole with a sand pump or bailer at suitable intervals. The "string of tools" (Plate I) ordinarily used with a portable outfit consists of a rope socket, jars, auger stem, and bit, each of these several parts of the string having separate and distinct functions. The rope socket, as its name indicates, is designed to be attached to the drilling cable, and is the medium through which the cable is connected to the tools. The jars consist of two heavy steel-bar links which, as the name implies, are used to jar or knock the drill loose when it becomes fast in the well and cannot be loosened by the steady pull of the cable. The jars are also one of the most important parts in a string of "fishing tools." (See Plates 2, 3, 4.) The principal function of the auger stem is to give weight to the blow of the bit, but, on account of the added length which it gives to the string of tools, it also serves to keep the hole straight. The stems used in the Philippines are usually 4 inches in diameter and from 16 to 24 feet in length. The drill bits generally used are known as the "California pattern" (Plate 5); but all of the types shown on the plate referred to have at times been used in the Islands. The California type, however, when "dressed" to a very blunt point, is, in the opinion of the writer, better than any other for general use, as the shales and clays which underlie a large part of the territory being drilled are very difficult to "mix;" and, while but little progress can be made in such formations with some of the other types, the average driller can usually drill from 20 to 40 feet per nine-hour day with a California bit properly dressed. The spudding bit is a short, light tool with long sloped shoulders, used in "spudding in;" that is, in drilling the first 75 to 125 feet.

The several tools described above are each fitted with threaded taper joints which require only a few turns in screwing them together or making up the complete "string." They must be screwed together very tightly, however, to prevent the joints from becoming loose when drilling and the consequent loss of all the parts below the loosened joint. As great stress is necessary in making up the tools, two heavy steel wrenches, weighing from 175 to 225 pounds each, are used in connection with a ratchet floor circle and jack (Plate 6), by which they are forced around until each joint is entirely screwed up. It is important that all threads be perfectly clean before the joint is screwed together as any foreign substance, such as sand or mud, will, if left in the joint when it is screwed together, cause it to become loose when drilling is commenced.

The cordage required consists of a drilling cable, and line, and casing line. (Plate 7.) The drilling cable is of hawser-laid hemp, from $1\frac{3}{4}$ to $2\frac{1}{4}$ inch diameter, and of sufficient length to permit the tools to which it is attached to be raised and lowered from and to the bottom of the well when completed. The sand line is a flexible wire cable $\frac{3}{8}$

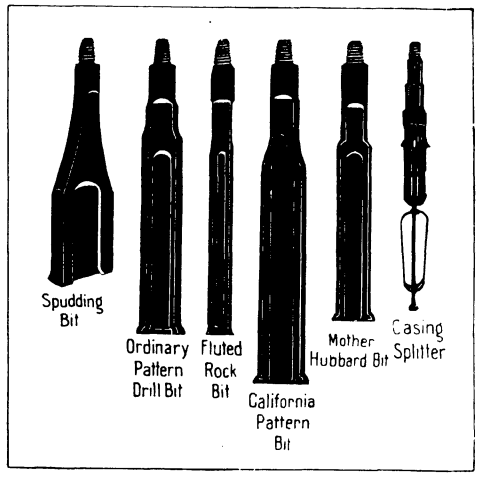



Plate 5.

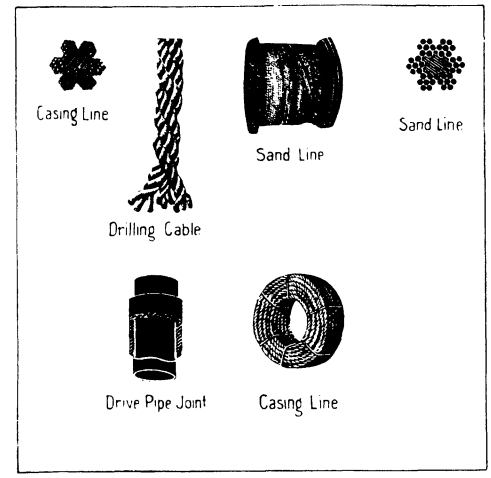



Plate 7.

to 9/16 inch diameter and, as its name implies, is used to hoist the sand or drill cuttings from the bottom of the well by means of a sand pump or bailer to which it is attached. The length of a sand line should correspond with that of the drilling cable. The casing line should be from 9/16 to 3/4 inch diameter, of flexible steel wire, and long enough to reach at least four times the height of the derrick, in order that it may be "rigged" through double and single purchase blocks when hoisting or lowering heavy lines of casing.

### DRILLING OPERATIONS—COMMENCING THE WELL.

The operation known as "spudding in"—that is, drilling the first 75 to 125 feet, the depth depending upon the material encountered—is accomplished by using the spudding attachment, as shown in Plate 8. The drilling cable is passed from the reel (bull-wheel shaft) over the upper spudding pulley, thence under the lower pulley and up to and over the crown pulley at top of derrick to the rope socket, to which it is attached. The walking-beam clutch is then slipped into gear and the engine started, the necessary motion being imparted to the tools through the medium of the double-pitman connection between the band wheel shaft cranks and the double walking beam. As the drilling progresses, the tools are lowered and the stroke adjusted by letting out cable from the bull-wheel shaft by use of the brake. Water is poured into the hole in sufficient quantities to form a thick liquid of the drill cuttings, and at intervals the tools are raised to the surface and the hole cleared of the liquid cuttings by running the sand pump or bailer.

A short cable, called the "spudding line," is generally used for this part of the work, as it is difficult for the operator to adjust the stroke of the drill if the entire coil of drilling cable is spooled on the bull-wheel shaft before the spudding is finished. Another reason for using a spudding line is that this part of the work wears a cable more than drilling with the walking beam, and it is desirable to have the drilling cable as near uniform in strength as possible throughout its entire length. When the drilling cable is used in spudding in, it results in weakening its lower section and increases the liability of a break as the drilling progresses, with the consequent loss of tools or an expensive fishing job. The tools used in spudding are the rope socket, auger stem, and spudding bit. The spudding attachment is also used in driving pipe.

### DRILLING WITH THE TEMPER SCREW AND WALKING BEAM

When a sufficient depth has been reached by use of the spudding method, the spudding bit is taken off, the jars and a drilling bit added to the string, and drilling with the walking beam is commenced. This is accomplished by suspending the drilling cable from the walking beam through the medium of the temper screw, to which it is attached by clamps designed for the purpose. (See figure 6, Plate 6.) Provision must be made for the up and down motion of the walking

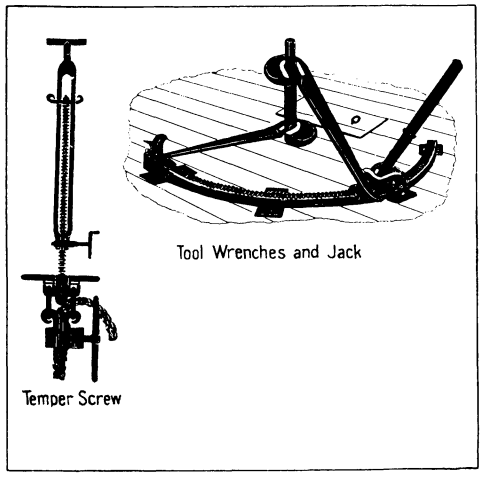



Plate 6.

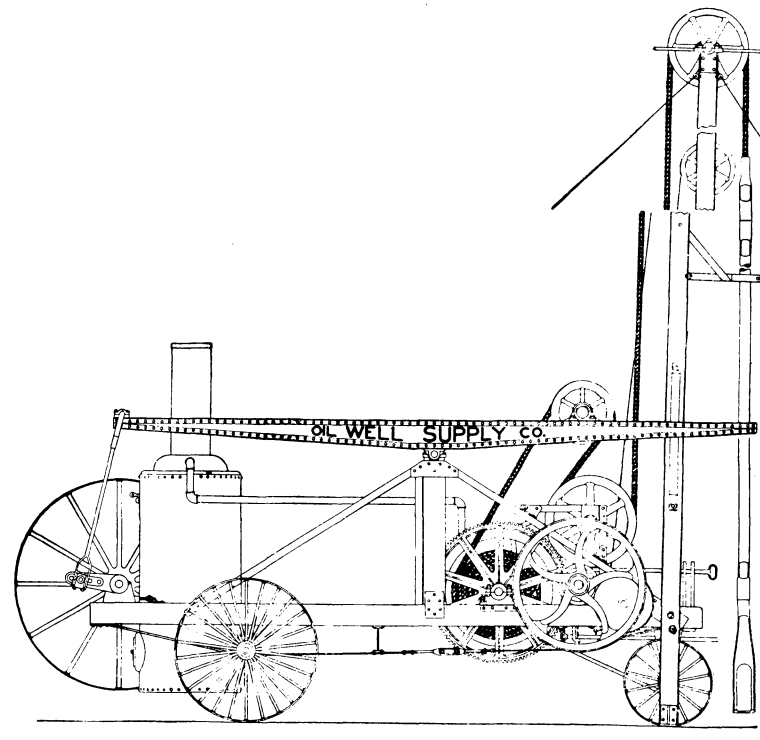
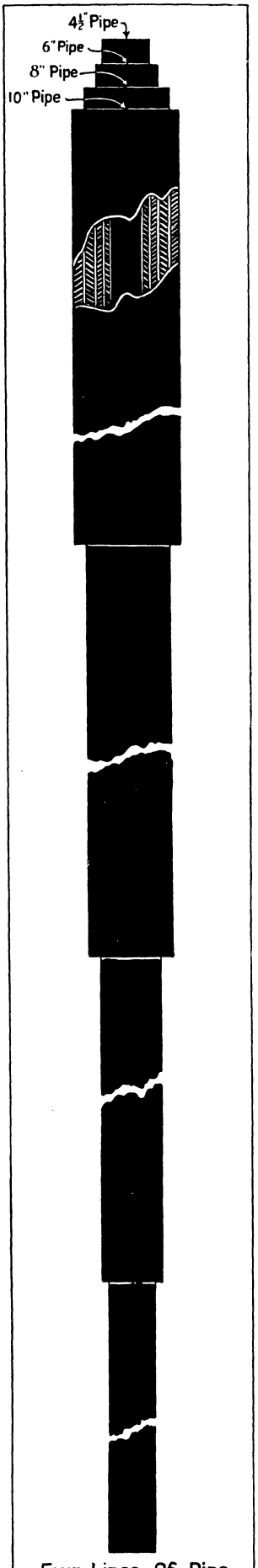



Plate 8.




**Four Lines Of Pipe Often Used In One Well**

Plate 9.

beam by coiling off 15 to 25 feet of cable on the derrick floor; this also permits the operator to rotate the temper screw when necessary. When all is in readiness the driller starts the engine and the walking beam begins to rock up and down, at the rate of 25 to 40 strokes per minute, the length of stroke being regulated by changing the wrist pin from one hole to another in the crank. The crank is fitted with four holes for the wrist pin and permits variation in the length of stroke from 12 to 40 inches. A comparatively short stroke is used for the first 200 feet, a medium from 350 to 600, and a long stroke below that depth. Until recent years it was popularly supposed among drilling engineers that by "turning the tools," (that is, revolving the cable first in one direction and then in the other) the hole could be kept round and true, and that neglect to do so would result in a flat or crooked hole. The theory was, that the rotary motion imparted to the tools by revolving the cable prevented the bit from striking two successive blows in the same place. It was finally discovered, however, that the drill bit leaves the rock unevenly and that the torsion of the cable under a strain rotates in opposite directions on the up and down stroke, bringing the bit into a new position for each stroke. This motion from the cable torsion is not very great until there is at least 300 feet of cable between the temper screw and the rope socket, and the tools should therefore be "turned" until that depth has been reached; otherwise, the hole may become "flat" (that is, oblong) on account of the bit striking several successive blows in the same place. An experienced driller determines whether or not the tools are working properly by frequently taking hold of the cable or temper-screw swivel, as by the "feel of the rope" he ascertains when the bit is striking a hard, clean blow, and whether or not the "jars are working." A driller can determine the proper tension of a cable only by practice, and must consider the weight of the tools, the depth of the well, the speed at which the engine is running, the age of the cable, and the amount of liquid in the hole. The speed should be so regulated that the cable tightens a little in advance of the blow of the bit, but not enough to retard the fall of the tools, so that when the bit strikes the rock it will have no time to settle or stick, but will rebound in response to the upward spring of the cable. The proper adjustment of the stroke is absolutely essential to rapid progress; and a mistake commonly made by beginners is to try to make the drill cut faster by letting out more screw. When drilling at a depth of 100 feet, the bit should swing 6 inches above the bottom of the hole when the walking beam is stopped at the lowest point on the downward stroke; at 200 feet, 12 to 15 inches; and at 500 feet, at least 30 inches; with a corresponding increase at greater depths. This applies to a new or partially worn cable. If an old cable is being used there will be less spring, and the distance given above should be shortened accordingly. This serves to illustrate the difference between the motion described by the walking beam and that of the tools. Another mistake sometimes made by amateurs is to allow the full weight of the tools to fall on the cable, the drill being stopped on the downward stroke before touching bottom. Such mistakes are more likely to occur in a deep well than in a shallow one, as the greater weight of cable added to that of the tools (especially if the hole is full of water) makes it very difficult to determine the motion of the tools by the "feel" of the cable.

When drilling with the walking beam, the temper screw is let out one or two turns at a time as the hole is deepened under the blows of the bit. At the end of from twenty minutes to several hours, the time required depending on the nature of the material being drilled and the length of screw in use, the screw has been run out its full length from 3½ to 6 feet, and the drill advanced an equal or even greater distance. The driller is then ready to withdraw the tools, which is done by first throwing the walking-beam clutch out and the hoisting gear in, and taking up to the slack cable which was run off to allow freedom of motion to the walking beam. When all the slack is taken up and the weight of the tools transferred from the walking beam to the derrick, the engine is stopped, the temper-screw clamps loosened and removed from the cable, and the temper screw shifted back to allow the free passage of the cable and tools. The engine is then started and the tools hoisted to the top of the hole, where they are swung to one side and made fast with an iron hook provided for the purpose.

The waste (drill cuttings or liquid mud, as the case may be) is then removed from the hole by running the sand pump or bailer until the hole is clean. Before lowering the tools again, the bit should be examined and if it is "losing its gauge" (that is, if the edges are sufficiently worn to reduce its diameter), a newly dressed bit should be substituted and all the joints examined, and tightened if necessary. If the hole is dry, water should be poured in, a bucketful at a time, until a sufficient quantity has been accumulated at the bottom of the well to form a thin liquid of the drill cuttings as the work progresses.

CASING THE WELL

Steel drive pipe of 10, 8, 6 and 4½-inch diameter, and ⅜, 5/16, 9/32, and 7/32 thickness, respectively, is used as casing to retain the wall of the well and prevent contamination by seepage of surface or sea water from the strata above the water-bearing rock or sand.

This pipe is fitted with threads and couplings, and the sections are tightly screwed together (Plate 7), forming a water-tight line from top to bottom. All of the sizes mentioned above are sometimes used in drilling a deep well (Plate 9); but the outside lines are usually withdrawn when the work is completed, only one line being permanently left in the well.

The writer has received many inquiries from interested parties as to length of time drive pipe may be expected to last under ordinary conditions. This is a question that cannot be satisfactorily answered at the present time so far as the Philippine Islands are concerned, as pipe placed in Government-owned wells during the years 1904 and 1905 is now in excellent condition. During the month of September, 1913, a line of 6-inch drive pipe withdrawn from the old customhouse well at Iloilo showed no signs of corrosion, and was apparently in as good condition as when first driven into the well in July, 1905. In this particular instance, although the pipe had been driven through salt-bearing sands and shale, and the outer surface exposed to salt-water seepage for more than eight years, the surfaces were clean and smooth, the factory and shipping marks clear and plain, and the threads in good condition on each joint of the 450 feet withdrawn.

In the United States many lines of drive pipe have been recovered from old oil wells after twenty years' use and found to be in remarkably good condition, the factory marks on the outer surface, in many cases, being quite plain.

In certain districts of Australia, however, pipe corrodes very rapidly, and it is often necessary, particularly in the Coonamble district, to put in new lines each year, while in other districts, pipe placed in wells as early as 1885 is still in good condition. Australian well owners have made tests with practically every kind of standard drive pipe obtainable from the United States, Great Britain, and Germany, but have failed thus far to find any that would resist corrosion in the deep wells in the Coonamble district. This matter was investigated by the Interstate Conference on Artesian Waters, at Sidney, Australia, in April and May, 1912; and while no definite decision was reached, the majority of chemists examined by the board were of the opinion that the rapid deterioration of pipe in certain sections of the Coonamble district was due, primarily, to the presence in the water of abnormal quantities of carbonic anhydride; and, secondarily, to the high temperature of the water. The data presented at this meeting showed conclusively that there had not been a single case of corrosion of casing in wells sunk to the water strata usually found at from 1,000 to 1,600 feet; and it was pointed out, in one specific instance (the Yuma well), that the well had been sunk to a depth of 1,200 feet, and after ten years' use the pipe was withdrawn and found to be perfectly sound. The well was then deepened to 2,171 feet, the old pipe being used as part of the casing in the newly drilled section. After a period of only seven months the flow suddenly decreased from a daily rate of 1,180,000 gallons to 600,000 gallons. Upon examination, it was found that the pipe (both the old and new) had corroded to such an extent as to cause its collapse. A comparison of the records of the analyses of the two waters brought out the fact that the amount of carbonic anhydride in the water from the lower stratum was several times greater than that in the water from the upper stratum. It was also shown that the water from most of the wells in which corrosion of the pipe had been rapid contained a high percentage of carbonic anhydride, and that the temperature of these waters was usually from 120° to 130° Fahrenheit. However, as these abnormal conditions are not found in Philippine waters, the writer is of the opinion that the standard-weight steel drive pipe used by the Insular Government may be expected to retain the wall of a well for an indefinite period.

## EXCHANGES.

Progress on the lower Ganges bridge, northern Bengal, India, is reported in Engineering News of September 4, 1913.

This bridge will carry the two tracks of the Eastern Bengal State Railway across the Ganges River some 120 miles north of Calcutta. A 5-foot footpath is bracketed on the outside of the downstream girder.

This will be one of the largest bridges in the world, total length from abutment to abutment being 5,890 feet. There are 15 through trusses each of 345 feet 1½ inches span, and 6 plate-girder deck approach spans 75 feet long. The foundations of the piers are 150 to 160 feet below low-water level. The Ganges at this point rises 31 feet during the monsoon season, and the bridge will have a clearance of 40 feet above high water.

The shore spans are being erected upon ordinary false work, while the intermediate spans are being erected on a service span 336 feet 5 inches center to center of bearings, which rests on the masonry piers and acts as false-work. This service span is floated from pier to pier on pontoons.

The power for operating the large erection plant is generated by two power houses, one on each side of the river.

The steelwork is supplied from England and the construction is being done administratively by the Indian public works department.

The estimated cost of the bridge, together with protection work, is ₱25,000,000, and including the approaches, ₱31,000,000.

The director of public works, Jamaica, reports for March 31, 1912, 2,180 miles (3,520 kilometers) of main roads in existence. These were maintained during the year 1911–12 at a cost of from ₱107 to ₱450 per kilometer, with an average of ₱244. Of this amount an average of ₱16.40 per kilometer was for minor flood repairs.

In Jamaica as well as in these Islands the fight is on for wider tires on carts. We quote the following:

"The proposals outlined in my last annual report for some restriction on the use of overloaded narrow tires have not met with the general support I had anticipated. This, I believe, is entirely due to misconception of what the extra weights and costs would amount to and also of the methods proposed to be adopted in their introduction.

"However, I have the courage of my convictions and am gradually introducing 4-inch iron wheels for use in the department with excellent results both practically and financially. Further, it is gratifying to know that the example having been set and the advantages appreciated, various property owners about the island have already decided in their favor and are adopting them, and also certain commercial firms with an eye to business are importing them. I am therefore prepared to await the effect of time and experience to justify my proposals."

Speaking of a new bridge completed in 1912 over the Johnson River, at St. Thomas, the director of public works of Jamaica says: "The extended use of ferro-concrete, which now very largely enters all previous schemes owing to the economy of the method adopted by the use of ferro-concrete piles and rolled-steel joists." His brief and pointed remark in regard to the growing use of ferro-concrete follows: "The extended use of ferro-concrete, which now very largely enters into the work of the department, has resulted in great economy in the cost of works carried out and the reduction of the amount of imported material and therefore saving in time as well providing more for local labor."

The following quotation from the annual report (1911–12) of the under secretary for public works, Western Australia, recalls some of our earlier experiences and difficulties in road maintenance in the Philippine Islands. The Secretary says: "In consequence of the abolition of special grants for maintenance of main roads, the various local authorities—and particularly those within the metropolitan area—have, to a large extent, ceased to maintain and reconstruct certain main roads which are sorely in need of attention. A great deal of consideration has been given to this somewhat difficult problem, and I earnestly hope that it will be solved in the near future."

## ON THE JOB HERE AND THERE.

Mr. R. A. White, lately district engineer of Rizal Province, has resigned and is on his way to the United States.

Mr. J. G. Beckjord, district engineer of Pampanga, is on his way to the United States on accrued leave. Mr. Beckjord does not expect to return to the Philippine Islands.

Mr. G. H. Shulte, an old time assistant engineer of the Bureau, is at Bayonne, New Jersey.

Mr. J. B. T. Coleman, an old Bureau man, is studying for an advanced degree (C. E.) at the University of Michigan.

Mr. Alison Higley, of the old supervisor organization, died lately in New York from a complication of diseases, resulting from amœbic dysentery contracted in the Philippine Islands.

Mr. B. H. Burrell, formerly of the Bureau of Public Works, is senior highway engineer in the office of public roads, United States Department of Agriculture, Washington, D. C.

Mr. W. P. Creger, at one time assistant engineer of this Bureau, is with the J. G. White Engineering Corporation, New York.

Maj. J. F. Case sends Christmas greetings to the "old bunch" from Havana, Cuba. He is still engaged on the installation of the Havana sewer system.

## PROJECT NOTES FROM THE DISTRICT AND DIVISION ENGINEERS.

### MANILA.

New construction work in the city of Manila handled by the building division of the Bureau of Public Works during September, October, and November, 1913, amounted to approximately ₱270,600.

Repair work on buildings in the city of Manila occupied by Insular Bureaus amounted to ₱105,500.

Electrical work which includes some 119 separate and distinct jobs amounted to ₱5,000.

The total expenditures of the building division for this period amounted to ₱387,000.

The concrete work on the girls' dormitory which is being erected on Taft Avenue has been carried from the level of the first floor to the level of the third floor, one-half of the latter being in place.

The fact that this building is a distinctly architectural piece of work requiring the greatest care and attention to details and finishing, makes progress somewhat slow. The contractor, however, anticipates completing this work within the contract time. The amount of the contract is ₱252,000, and the work completed to date has been ₱80,000. The electrical installation of this building is being executed by Germann & Co., electrical engineers of Manila, for the sum of ₱10,245.

The grounds immediately adjoining the University Hall have been filled in with earth suitable for growing grass and shrubs, thereby giving greater appearance of finish to the entire building.

Although the aquarium has been completed and accepted by the Director of Science minor repairs and alterations have prevented the opening of the aquarium to the public. The iron frames which encase the glass windows of the aquaria have been waterproofed with bitumastic enamel and various plumbing defects only discovered after actual operation of the system are also receiving attention.

The south Bureau of Supply bodega floor was completed in the latter part of July and the second floor was finished about September 10. Delmar-Clinton Smith secured the contract for the main floor of the south bodega and also the floor of the north bodega. The second floor in south bodega was erected by John Gordon and the whole work was of such a nature as to call forth favorable comment from the Insular Purchasing Agent. Both buildings have been turned over to the Insular Purchasing Agent and receipt obtained for the same in the later part of November.

The exterior of the buildings are being waterproofed with a mixture of dehydratine and pumice.

The contract for the erection of the dispensary was awarded to John Gordon and he proceeded with the work upon completion of the second floor of the Bureau of Supply bodega. Concrete has been completed in the building itself which is now ready for the roof trusses. The waiting room connecting the present dispensary with the new addition is now in progress and the concrete will all be poured in this part of the building by December 31.

The reconstruction of section 2–7 in the Ice Plant has been completed within the estimate and is now in operation. Section 3–8 is now under reconstruction. The reconstruction of each section costs approximately ₱120,000 and takes one hundred and twenty days to complete.

### ALBAY PROVINCE.

On October 12, Albay Province experienced the highest water on record in all her larger rivers. It was fortunate that the high water came at that time instead of later. Construction had just begun on the Argao River bridge so the structure could be raised with very little extra cost over the estimate. The new high-water mark was within 0.25 meter of the proposed bottom of girders. At the same time about 10 kilometers of first-class road in the province was under water causing a damage of approximately ₱4,000 by washing out binder, etc.

The Legaspi–Tabaco and Tabaco–Ligao Roads were washed out at the lava bed sections. These were expected to go out, but in addition to this a section of fill on the interprovincial road was destroyed delaying traffic about two weeks. The Quinale River bridge at Malinao was under construction, the steel work had just been completed and luckily false work removed. Laborers were working on the fill between spans and the approaches, and about half the fill that had been placed was destroyed. High water was 0.60 meter higher than any former records at this bridge.

On December 6, the Quinale bridge was opened for traffic, thus opening the road into Tiwi and Naga for automobile traffic. On this date we were short 90 boards for flooring. As everything except the floor was complete, old 2 by 12 inch boards that had been used for forms and scaffolding were placed temporarily and traffic permitted to use the bridge. Since that date, however, the 90 boards have been received and the bridge entirely completed December 20. This was the first and only steel bridge ever constructed in the Province of Albay.

The first of the new markets, under construction in seven municipalities in this province, was completed on December 8. This is a 21 by 39.8 meter standard type A building, built by B. F. Mills at the contract price of ₱12,500. This building is located at Ligao, 31 kilometers inland from nearest shipping point. One group of tiendas is also to be built at Ligao.

Kilometer 6, Tabaco–Ligao Road, Albay Province.

Contracts have been let for market buildings at Tabaco, Legaspi, Daraga, and Guinobatan, and the towns of Camalig and Oas will soon be advertising for bids on markets.

All culvert work on the Malilipot–Bacacay Road was finished the first week in December. Funds have just been made available for road work which will begin at once. This road is 6 kilometers long connecting the town of Bacacay with the Legaspi–Tabaco Road at Malilipot. On this road there is a 300-meter section of lava bed. This material called "lava" is only volcanic sand. During a storm the water rushes down with a terrific force, but within a few minutes after the rain ceases there is no sign of water. This section is higher than the adjacent road on either side so it cannot be bridged and no ordinary form of surfacing will stand; therefore the method adopted is to build a baffle wall on either side of the road about 0.30 by 1 meter deep and grout in between, leaving the top of roadbed the same elevation as the natural ground. When the rush of water does come it will flow over the road and do no other damage than perhaps leave a thin layer of sand which can be quickly removed.

The project known as Albay Road extension has been completed. This was a transfer of all streets around the provincial grounds from municipal to provincial supervision. They have been put into first-class condition and greatly improve the looks of the provincial grounds.

Mr. F. T. James, contractor, has a foreman on the ground and all piles have been cast for the bridge over Argao River. On account of his pile driver being detained in the northern provinces, actual construction has not yet begun.

Grading is progressing nicely by administration on the Tabaco market site. Bids were so high for doing the work by contract that all bids were rejected and it was undertaken by administration.

The labor proposition on the Catanduanes Trail is still a source of annoyance. We have decided to import labor from Albay and Camarines, but whether this will prove a success or not remains to be seen. Work at present is about 20 kilometers from the nearest barrio and the isolation does not appeal to the natives of Catanduanes.

The increased auto traffic over the roads leading out of Legaspi has made the widening of the roads necessary and has materially increased the cost of maintenance. There are at present 22 passenger trucks running out of Legaspi and the number of touring cars for hire and private cars are proportionally larger. Resurfacing is now going on between Legaspi and Albay and the metaling is being widened to 6 meters.

The well-drilling outfit working at Malinao, on December 12, about 10 a. m., struck a nice vein of water at a depth of 375 feet. This was reached with a 6-inch pipe and has a flow of about 45 gallons per minute. So far there has been no test made, but it is apparently a good drinking water. Just as all artesian wells in this section the water has quite a sulphur odor and taste.

### AMBOS CAMARINES.

During the past month the partially inclosed alleyway, connecting the main provincial building with the annex, became so dangerous that the following repairs were made; the wooden floor beams were replaced by 12-inch 31.5-pound I beams and floor sills and floors were relaid, this making a stronger construction and presenting a neater and more attractive appearance.

An unprecedented rainfall was experienced in Camarines during the baguio of October 9, 1913, and new high-water marks were established on the rivers throughout the province. The Bicol River was an expanse of water several miles in width, making the entire section from Bato to San Miguel Bay one large lake. The roads in many places in the Caceres region were covered with water; the entire section from Iriga to Bato could be traveled in a banca. With the exception of the failure of the Spanish masonry culvert No. 43.6 on Nabua Bato Road, and about 300 meters of road on kilometers 30 and 50, little serious damage was done.

A reconnaissance was made of three routes connecting the Partido de Lagonoy with the Rinconada, Nueva Caceres district, via Calabanga to Goa, Iriga–Sagñay, and Pili–Tigaon, the last of which is most favorable. This route is about 28 kilometers long, 15 kilometers passing through a rice section and the remainder through a rich hemp region; the road is tangent in direction, with easy grades and a small number of bridges and culverts; the probable cost per kilometer of first-class road, including bridges and culverts, will be ₱11,000.

The section of road from the Bicol River to Minalabac is under construction: work consists chiefly in the repair of the old Spanish subgrade and metaling the 5 kilometers with a 3-meter width of gravel.

Bids for the construction of the Bato market were advertised for; only one bid being received, the municipal council requested the work to be done by administration. The materials for the market have been requisitioned and the work will start on their arrival. Pedro Flores will be the foreman in charge.

Contractors Allen & James are now casting the reinforced-concrete piles for the Naga Bridge.

Work projected in the Partido Lagonoy for the coming year is as follows: Construction of 5 kilometers of first-class road; this connects the Goa–Sabang, San Jose–Lagonoy, and the Nato–Tigaon Roads. Resurfacing of 8 kilometers on the Goa–Sabang Road. Construction of 5 by 4 meter culvert on Nato–Tigaon Road. Construction of a concrete causeway at the ford on the Rangas River. The latter is considered as the most important by the people in this district, as this is the only place not easily passable for automobiles in entire road system.

The Nueva Caceres Boundary Road reconstruction is now completed to kilometer 28. During the month of November labor and transportation became easier, enabling us to accomplish a more satisfactory amount of work. Difficulty was experienced in getting the road through the gumbo sections to hold up under the heavy automobile truck traffic.

Reconstruction on the Bato–Argus River section will be started about January 1. This entire section will be resurfaced, surfacing widened to 4 meters, and as much as possible of the road brought up to a standard 7-meter cross section.

No bids were received for the construction of the 20-meter reinforced-concrete arch on the Iriga–Buhi Road, so work was started by administration. A temporary structure for the diversion of traffic was constructed, the old bridge and abutments removed, and the excavation made. Progress is very satisfactory.

The municipality of Iriga has the following projects either in construction or awaiting plans: Construction of road from kilometer 36 to barrio of San Agustin, grading of new market site, removal of present market building to new site, construction of several rows of concrete tiendas, and the construction of 150-foot steel-span truss bridge with concrete abutments. Work on the road is nearly completed; this was entirely supervised by Mr. Manuel Cressini, the municipal president. About 40 men are grading the new market site; a very heavy fill is required here. Work is under the district engineer, but the daily supervision is done by Mr. Cressini. Work is progressing satisfactorily and economically, chiefly due to the interest shown by the president and his influence in getting plenty of good labor.

The Partido Lagonoy has an automobile passenger truck running from Sabang to Goa. The company expects to put on an additional car on the Nato-Tigaon side, both cars to run on regular schedule and transfer passengers at the Rangas River.

The cart trail from Guijalo to Caramoan will be opened for traffic on January 1. On the opening of this road transportation rates on all imports and exports drop from 40 cents to 8 cents per picul. The local agent ordered 50 pairs of Bilibid cart wheels for use on this road.

### ANTIQUE PROVINCE.

The construction of standard school building (revised plan No. 3) in the municipality of Laua-an is now under way. It is expected that this building will be completed in February, 1914.

The Bocboc bridge on the San Jose–Dao Road is nearing completion. It consists of four 7.75-meter spans reinforced-concrete slab and girders on concrete pile bents.

The San Jose–Patnoñgon Road construction is now completed, making the total distance of 20.7 kilometers between the two municipalities first class. Also the first-class road on the San Jose–Dao Road including kilometer 14. All in all, this province has at present a total of 46.7 kilometers of first-class road, representing an increase of 15.7 kilometers over the total at this time last year.

The Province of Antique has approximately 200 kilometers of roads of all classes, perhaps more than any other province of the same class.

The municipalities of Sibalom and Culasi are clamoring for protection. During the rainy season these two municipalities are in continuous danger of being flooded. Culasi has been flooded six times this season. Sibalom has been flooded but once. The necessity for river control work is realized by all Government authorities. A special effort is being made to secure the necessary funds.

### BATAAN.

With the completion of the collapsible deck bridge over Talisay River, there are now 36 kilometers of continuous road in the province. This bridge of ten 20-foot spans was constructed for ₱2,922.43, or ₱46.27 per lineal meter.

The standard 5 by 2.5 meter culvert on pile foundation at Hermosa was completed. Work has now started on another culvert 5 by 3 meters on pile foundation. Both are on the Balanga–North Road.

Work on the bank protection of the Talisay River at kilometer 1.4, Balanga–South Road, is progressing very rapidly.

### BATANGAS PROVINCE.

The provincial board has passed its regular half yearly resolution designating anew the first-class roads in the Province of Batangas. The total increase for the calendar year 1913 has been 21.91 kilometers. This latest designation is on the new system of numbering kilometers, all distances now being given from Manila. Batangas, the capital, is 115 kilometers. Of this distance 89 kilometers is first-class road, the remaining 26 kilometers being second-class dirt road.

No bids were received either in Manila or locally for the proposed Lemery presidencia. This building is to be the new standard "Scheme A" building. It is thought that at least the local bidders were scared away by the large amount of fancy and ornamental work on such a small building. The work is to be done by administration.

A contract has been awarded for the construction of a standard revised No. 7 school building in Balayan. The contractor is to furnish all labor and material necessary with the exception of the cement and steel, which are to be furnished by the Government. On account of the swampy land on which the building sets, the bearing area of all footings has been at least doubled and the latter have been reinforced in two transverse directions. In addition to this, the roof system and back walls on the end sections have been redesigned so as to permit future extensions to be made without tearing out any expensive work. The bid, including these changes and additions, was ₱12,766. Including steel and cement, but not the 10 per cent surcharge, this brings the cost to ₱14,552.

The reconstruction of the provincial jail, noted in the last issue of the Bulletin as having been undertaken by administration on account of the excessive bids received for the work, has been finished. The lowest bid (three received), with surcharges, amounted to ₱8,170. The work by administration, including considerable extra work, cost slightly less than ₱7,000. The jail now boasts of an adequate isolated insane and leprosy department. The authorities have become so enthusiastic over the new arrangements that they now propose having separate quarters for the attendants and an entrance entirely separate from that of the jail proper.

The construction work on the Sabang bridge proceeds slowly. The abutments, pier, four-arch rings, spandrel walls, and part of the floor slab are practically finished. The picture shows the bridge on December 9, just before starting to take down the false work under the ribs. Before pouring the concrete in each rib a dead load of 12 tons was distributed at the arch crown. Under this the forms settled at the crown an average of 7 millimeters. When the arch rings were poured and the work finished, there was an average further settlement of only 2 millimeters. This is a remarkable indorsement of the style of false work used and so clearly shown in the picture. The great height of the bridge caused no inconvenience or unusual expense as far as the false work was concerned.

The Lipa market buildings have been completed. This plant now consists of three standard buildings each 21 by 43.50 meters and a block of 10 standard tiendas. The municipality of Lipa is to be congratulated on the progressive policy shown by its public officers. No sooner were the buildings finished than the municipal council requested an estimate for making the streets within the grounds first-class macadam. They immediately supplied the ₱2,750 necessary, and supplemented this with ₱600 for public outhouses and ₱1,000 for reconstruction of the slaughterhouse. Now they have requested a plan and estimate for a fence to surround the grounds. It is rare, indeed, that a municipality is willing and able to supply funds to finish market sites in a manner befitting its new buildings.

Construction work has been started again on the Balayan-Tuy Road. The work on the terminal, 1.5 kilometers in Tuy, had to be abandoned on account of the severe rainy season and lack of funds. It is expected that this road will now be finished without further interruption.

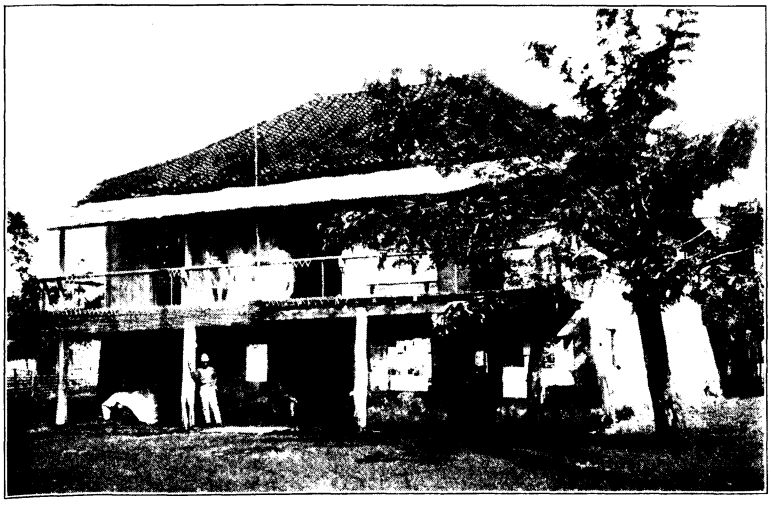
Surveys for final location will be finished and active construction started within the first week in January on the Batangas–Ibaan Road. This road passes over the new Sabang bridge and is a part of the Batangas–San Juan de Bocboc Road project. When finished a vast productive section will be opened to traffic that heretofore has had no passable outlet during the rainy season.

## BOHOL PROVINCE.

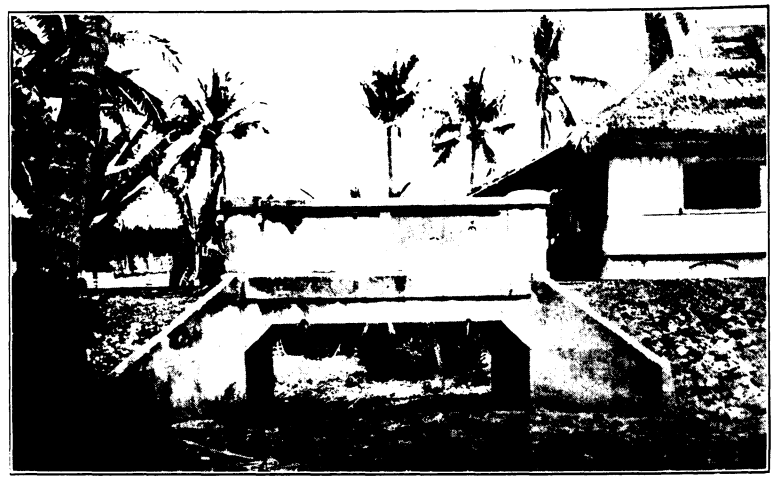
Work is still progressing slowly on the substructure of the Loay swing bridge. The two central piers and one abutment are complete. The other abutment will be completed in the immediate future. According to information received from the contractor's representative, the steel erection will begin early in January.

With regard to the erection of the 90-foot span, it is proposed to erect it complete on a scow and then float it to position at high tide. This will save a great amount of false work construction and should occasion no great difficulty.

The contractor is the Insular Construction Company of Manila. A. H. Donovan is the foreman in charge.



Balayan municipal building, Batangas.



Culvert on Calapi–Tubigon Road, Bohol.

The Tangohay bridge (five 7-meter concrete girder spans with concrete pile foundations) has been completed at an approximate cost of ₱9,500.

Balbalan bridge (three 7-meter concrete girder spans) will be completed early in January at an approximate cost of ₱6,000.

Work on the Tubigon–Inabanga section of the Tagbilaran–North Road has been renewed and an endeavor will be made to complete this section during the coming year. At present a narrow surfacing is being placed which will be widened as the traffic increases. This is a section 17 kilometers long through a very fertile country and will require a first-class road in the near future. All small bridges are being built as the construction progresses. There are three comparatively large streams over which the present temporary structures will be reconstructed.

Very little other road work is being done except what is necessitated by the rains. Culvert work is also at a standstill due to lack of funds.

Maribojoc market will be completed and opened for business early in January. This is a standard market, 15 by 39 meters, and the final cost will be less than ₱10,000.

Work on the Loon market is now being rushed. This should be completed by the latter part of January.

Material for Loboc market has been ordered and construction should begin in January.

Tubigon market will also be begun some time in February.

The work on Calape market is still pending due to difficulties in obtaining title to market site. It is expected that these difficulties will be overcome in the near future.

The Tubigon school, a standard plan No. 7, has been recently completed without ceilings and partition at an approximate cost of ₱13,200. The municipal council has borrowed ₱1,000 from the provincial government to complete the building. This work will be done in the early part of 1914. The completed building will cost about ₱15,000.

The construction of a standard school building in Inabanga (plan No. 6) and Jetafe (plan No. 3) will begin in the near future.

## BULACAN PROVINCE.

The town of Baliuag has practically completed the preliminary arrangements for the construction of a ₱40,000 market.

Construction work on the Manila–North Road near the town of San Miguel is progressing rapidly. The section between San Ildefonso and San Miguel will be completed by January 30.

The Insular Construction Company is making very satisfactory progress on the camarin for the Bulacan market. This camarin is of standard design, 21 by 43.5 meters, with galvanized-iron roof.

The concrete work on the Malolos intermediate school has been completed and the roof is in process of erection. It is thought that the building will be completed by the middle of February.

Two of the Hagonoy bridges, Allen & James, contractors, have been finished. Three are still in process of construction. The contractors agreed to finish these bridges on August 1. Failing to accomplish this an extension of one hundred and ten days was asked for and obtained.

Though no special difficulties were encountered, this extension was allowed to expire before all of the piles had been driven and the province is now collecting the penalties imposed by the contract.

The municipality of Bulacan has voted to construct nine tiendas on its market grounds. Because the only bid received was excessive, these tiendas will be built by administration.

The municipality of San Ildefonso has voted ₱12,000 for the construction of a No. 7 school building. After January 1 another ₱1,000 will be made available. If sand, gravel, and supplies are hauled free it is thought that the building can be completed for this amount.

The Bocaue school, a seven-room Gabaldon school, was completed and occupied about the 1st of October. The building has cost the town of Bocaue to date ₱13,376.08 which has been expended as follows:

| | |
|---|---|
| Labor and supervision | ₱3,954.30 |
| Materials | 7,958.17 |
| Miscellaneous | 248.87 |
| Surcharges | 1,214.74 |
| Liabilities (about) | 5.00 |

A little extra form lumber and a few supplies were sold to other jobs. The items so transferred total ₱122.61.

The building, as constructed, differs from the standard plan in the following points:

1. The partitions are of reinforced concrete. This should not increase the cost of the building, but it is thought that in this case it did do so slightly because the work was delayed by a shortage of materials until the other concrete work had been finished.

2. The window frames, windows, and doors are of narra. The frames as well as the doors and windows were built by the trade school. The work done was of fair grade, but the price was not below the prices prevailing in the local market and the time consumed by the trade school to construct these articles was excessive. The change from the woods specified for this work to narra cost about ₱600.

3. Blackboards were cast in the concrete walls. The workmen were new at this sort of work and they did not produce the best possible results. However, the concrete blackboards seem to be serving their purpose very well. These boards cost about ₱100.

4. The ceilings were painted instead of oiled. This cost about ₱50.

5. Iron hooks and hangers were used on the windows instead of the brass fixtures specified. These were heavily painted. This change reduced the cost about ₱50.

The final cost for the building was, therefore, increased something like ₱700 by the changes made.

The building was constructed by a native foreman and is a good example of what can be done toward cheaper construction work if competent Filipino foremen are employed.

## CAPIZ.

The materials for the erection of the Romblon coal storehouse are all on hand, excepting gravel, and plans for its early completion are under way. Bids for its erection were published and the bid of Mr. George Studier was accepted December 12, 1913. This was due to a considerable building program under way in this province which made outside help desirable.

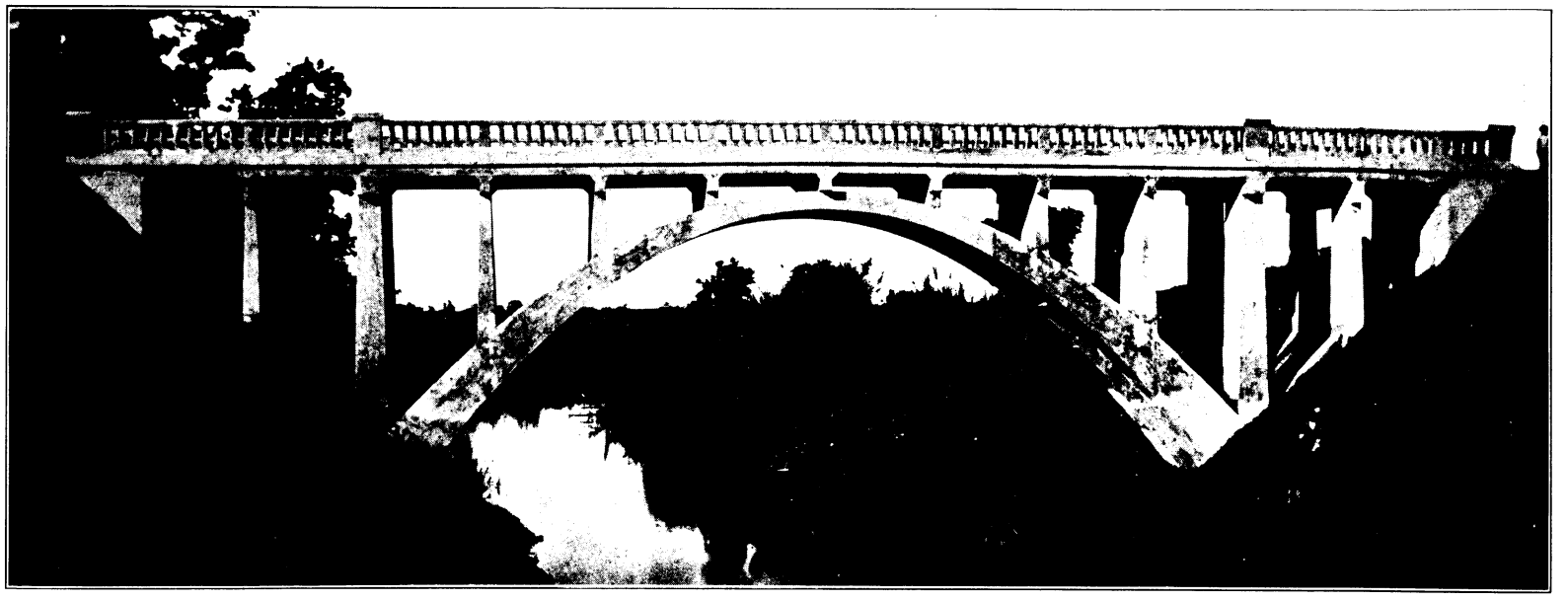
By administration a 20-room schoolhouse at Calivo is under way and plans for the erection of a 6-room building at New Washington are being rapidly developed, as it is contemplated having the New Washington school completed about the same time as the Calivo school. Bids were advertised for its erection and as they exceeded the amount available, the work will be done by administration.

The Cuartero school had just recently been completed and the construction forces have been transferred to the Calivo and New Washington school building projects.

Progress on the Panitan–Pilar Road for the past six months has necessarily been slow, due to difficulty in getting the traction engine and rock crusher across the Panay River at Panitan. The province awaited the completion of the Panitan bridge before transporting the traction engine and crusher to the quarry site, where it has been installed and working to such advantage that the surfacing of approximately 4 kilometers of road before the close of the year will be effected. On this road during the waiting period, one 12, one 9, one 8 meter girder bridge and various culverts were constructed.

Progress on the Busuang–Malinao Road has advanced by such strides that approximately 8 kilometers of first-class road will be reported by the end of the year.

The Tangalan–Ibajay Road progress shows subgrade nearing completion, approximately 5 kilometers of road surfaced, and various culverts constructed.



Maraburab Bridge, Cagayan Province.

The Capiz–Libas Road is unique inasmuch as it is only 4.4 kilometers long and that 4 kilometers of the road are continuously in nipa swamp. At high tide the entire 4 kilometers are surrounded by water and barrotos ply up and down the canals along the side of the road. The port of Capiz is Libas and the first impressions of Capiz, when arriving by boat, are truly one of tropical and jungle impressions. The jungle impression is soon dispelled by well taken care of roads, the clean streets of Capiz, and its beautiful, picturesque, old and new modern artistic public structures and parks.

All the work enumerated in the Bulletin notes has been done by administration, excepting the erection of the Panitan bridge.

The Panitan bridge, whose construction was begun in January, 1913, was completed in November. This structure comprises two 80-foot steel truss spans and two 10-meter I-beam approach spans. The cost, including a temporary wood approach span, back fill, and surfacing, was ₱54,439. The work has been done in a painstaking, efficient, and careful manner by the contractor, the Insular Construction Company.

Inasmuch as the opening of this bridge gives access to an important sugar-growing section, of which the two principal barrios are Pontevedra and Pilar, considerable interest in the project was displayed by the people of the province.

The first load to pass over the bridge was a 12-ton traction engine, drawing a No. 10 Champion rock crusher.

The next road project under consideration is the Loctugan–Ivisan–Mianay–Sigma Road. As this will be a railroad feeder, part of the funds for construction will be requested from the Insular Government.

## CAGAYAN PROVINCE.

Work is now in progress repairing the damage done the causeway across the Pangul Valley in the municipality of Solana. Occasionally, owing to the narrowing of the valley some distance below the roadway, the water rises higher than it is practical to raise the roadway and to prevent or minimize the damage to the road during such floods, it has been decided to increase the slopes on the downstream side to a 3 to 1 and on the upstream side to a 2 to 1 and sod the embankment with bermuda grass.

A modern 3-room reinforced-concrete school building has been completed in Enrile and accepted by the Director of Education. Compared with the same montn last year the enrollment shows an increase in attendance of 15 per cent.

Material has been requisitioned for a similar building in Peñablanca and construction will begin as soon as it arrives.

The construction of the second-class road over Claveria Hill, for which an appropriation of ₱10,000 was made in May, is nearing completion and with a small additional expenditure to repair other sections of the road, loaded carts can, for the first time, make the trip from Claveria to Sanchez Mira.

Construction work on the Tuguegarao–Alcala Road, which was begun in March, has progressed rather slowly on account of the heavy rains of the past season and minor troubles affecting the organization, but on the whole the results achieved are gratifying. Unless unforeseen difficulties arise, the 7.4 kilometers under construction can be completed within the approved estimate of ₱88,690. Two reinforced-concrete culverts, each 9 meters in span, and 15 reinforced-concrete culverts, each 61 centimeters in diameter, will be required to provide drainage for the heavy annual rains.

While only 3 kilometers will be declared first class and put under regular caminero maintenance January 1, 1914, the work is about 75 per cent complete. A surfacing of screened gravel 4 meters wide and 20 centimeters deep is being placed in two courses and thoroughly rolled, sandy clay being used as a binder.

An effort was made to make use of what is known as the "paquiao" system in constructing embankment, but was unsuccessful owing to the inability of the foreman in charge to gain the confidence of the laborers, and the many cuts and fills sufficiently large to require the use of tramway and cars for economy in construction.

## CAVITE PROVINCE.

The first-class roads of this province have not received the full amount of maintenance that they should have had to keep them in the best of condition.

There are at present 52.5 kilometers of first-class roads. During 1913 the sum of ₱26,031.54, or approximately ₱496 per kilometer, was spent for maintenance. This did not allow sufficient rolling, and very poor gravel had to be used.

For 1914 the sum of ₱36,700 has been recommended to be made available for first-class maintenance. This is equal to approximately ₱700 per kilometer. With this amount a better class of gravel can be used and every kilometer can be rolled.

The province is maintaining in such a condition that they are passable at all times of the year to automobile traffic 26.5 kilometers of second-class roads that connect with the first-class system. During the year ₱12,768, or ₱480 per kilometer, was expended for this work. The conservation is of such a nature as to permanently improve the roads, making the surfacing such that only broken stone will be required for a first-class road as the subgrade will be in excellent condition; however, during the rainy season they are a bit soft for extremely heavy loads. This makes 79 kilometers of connected first and second class roads open the year around.

The new school building projects will be opened this year, one standard plan No. 6 in the central barrio of Santa Cruz and one standard plan No. 3 in the barrio of Dasmariñas.

During the year 1913 there were nine school building projects completed, consisting of one No. 10, two No. 6, three No. 3, two No. 2, and one No. 1 standard plan buildings. Of this number five were new projects and the other four were old projects that had never been completed. Six of these buildings have had the galvanized-iron roofs painted with a rust inhibitive paint.

The Dasmariñas–Silang Road culverts have all been finished and stone is on hand to finish road into Silang. However, there still remain 1½ kilometers of surfacing to lay and compact. On account of the long haul for materials from Binakayan to Silang, a distance of 30 kilometers, it is extremely hard and very expensive to get carts. This road should have been completed in 1913, but carts were not available till March and the road could not then be finished before the rains set in.

When work was suspended last year, carts were being paid ₱8 per cubic meter for materials and 90 centavos per barrel for cement.

Plans and estimates for the Julian bridge have been completed. This is an old adobe stone structure built in 1860.

It consisted of two 7-meter arches. During the high water in September, 1912, the upstream side of the pier was undermined causing the pier to break in half parallel with the center line of the two arches, and half of each arch ring fell into the river. Sufficient width remained standing, however, to allow traffic to pass. To eliminate danger of the fill over the stone rings falling down, a temporary wooden structure was built over the span to carry the traffic. The new plan for this project is a single span, open spandrel, 14-meter concrete arch. The grade has been raised 1 meter to give more clearance for brush and trees that come down the stream during high water.

The total cost of clearing way old masonry, riprapping the stream banks with same, building temporary bridge and road during construction, and building the new bridge and the two new approaches approximates ₱15,000. There is now available ₱10,244.50. This bridge will have to be built this year as it cannot possibly stand another flood season.

The Naic–Marigondon Road is in a very bad condition on account of no provision being made to carry drainage across it in several places. The land on both sides for the entire distance (7 kilometers) is irrigated and in several locations the farmers cut the drainage

Cagayan Iguig Arch, Cagayan Province.

of their canals into the road. If these places had culverts to carry this water and the low holes filled, the road could be made passable practically the whole year.

The provincial governor is endeavoring to secure a loan for the construction of the Julian bridge and then transfer ₱5,000 from that project to the Marigondon Road to built these culverts.

During the last two months of 1913 considerable free work has been done on roads around Alfonso, Bailen, and Marigondon. The district engineer supplied 100 picks and shovels, dynamite, and a capataz to superintend the shooting of the explosives, while the presidentes of the above-mentioned towns got donations of money and labor to repair the bad places in the roads that radiate from their towns. Some 100 men have worked a total of ten days repairing the roads so that now they are in such condition as to allow the local products to be hauled out this dry season. The dynamite was used to shoot out bowlders at river crossings.

It is sincerely hoped that an appropriation of ₱50,000 will be made available this year for the continuation of the construction of the Naic–Indang Road. As stated in the Quarterly Bulletin issue of October 1, 1913, 7½ kilometers of surfaced road have been completed and material, broken stone, gravel, sand, cement, etc., are on hand to finish kilometer 10.

With ₱50,000 the road through the entire Naic estate to the end of kilometer 13 can be completed before the rainy season begins. This will put the road over the worst places, as most of the subgrade is in adobe from here on to Indang. Deep holes have been washed into it, but a gang of 20 men could fill them up in one month so that the entire road would be open at the end of this dry season.

The trees that were planted along the road did not do well. These were Cassia Siamea, sampaloc, and rain trees. Of the 240 planted only 30 are growing. Most of the rain trees have pulled through.

### CEBU PROVINCE.

The reconstruction and repair of the Butuanon bridge has been completed, together with the backfill and approaches. This structure was a deck truss 23.63 meters long built by the Spanish Government between 1895 and 1898. The superstructure was well built, but the south abutment washed out in the typhoon of October, 1912, letting one end of the bridge down into the river bed. The railroad bridge just above the road was also lost. The reconstruction consisted of jacking the superstructure up onto the north abutment, building a concrete pier on a pile foundation to replace the lost abutment, and adding a 9 meter I-beam approach span. The old cast-iron handrail was so badly broken up that a standard concrete balustrade was used in its place, giving the bridge quite a modern appearance.

Work on the Cebu–South Road has consisted mostly in constructing short relocations between Argao and Dalaguete to avoid steep grades on the old Spanish location. One such relocation, about 700 meters long, has just been completed whereby a 6 per cent grade is substituted for one of 15 per cent on the old line. This does away with the last long steep grade between Argao and Dalaguete and a few thousand pesos more, judiciously spent, will open the road for autotruck traffic.

Barili–South Road surfacing has now reached kilometer 81 in Ronda and the subgrade work to kilometer 83. This places Ronda on the map as far as auto traffic is concerned and enables the people of Moalbual and Badian to take advantage of the more rapid means of transportation when necessity arises. This road will eventually reach Alegria at kilometer 115 and connect there with a good road to Samboan about 25 kilometers further down the coast.

Under maintenance of first-class roads some ₱55,000 are being spent on resurfacing. A rock quarry was opened November 24, 1912, at Danao to provide suitable material. The rock is crushed and loaded onto Philippine Railway cars and shipped to the location where the resurfacing is in progress. Some time ago a contract was let for the operation of the quarry and crusher, the province agreeing to pay ₱1.80 per cubic meter for crushed rock on board the railway cars in Danao. Under the terms of the contract the contractor was furnished powder, dynamite, caps, and fuse, but the cost of same was to be deducted from moneys due him. To date, after several thousand cubic meters of crushed rock have been produced, the cost of the above items average about ₱0.04 per cubic meter. The writer knows of instances where the explosives used in solid-rock excavation have cost over ₱0.25 per cubic meter and has never heard of it running less than ₱0.15 where the stone was broken small enough to feed into a crusher. This illustrates better than any theoretical argument the advantage of taskwork over day labor.

Activity in schoolhouse construction is on the increase. Standard plan No. 7 buildings have been completed at Oslob and Boljoon, together with a plan No. 10 at Dalaguete. The contractor is busy on the Argao school, plan No. 10, and a 2-room building is going up at Candaguit, a barrio of Sibonga. A 20-room building is projected for Cebu City and a 2-room school is being advertised for construction in the barrio of Basac, Cebu. The division superintendent of schools advises that he will have funds for the construction of plan No. 6 at Alegria, Tuburan, Pinamongahan, and Daan Bantayan in the near future.

Market construction occupies an important place in public works operations at present. The Carcar, Opon, and Oslob markets have been completed while the Dumanjug, Dalaguete, and Barili markets are being built by administration, the two former being almost completed. The Argao market is being constructed by contract. The total expenditure for markets for the period from July 1 to December 31, 1913, will be approximately ₱68,588.88.

A 14-meter I-beam footbridge across the spillway of the Osmeña waterworks dam has just been completed. The completed spillway and flume were given two tests on October 27 and October 30 when the head of water over the spillway was 20 and 30 centimeters, respectively. To prevent water from scouring the seamy rock along the flume and canyon the worst places have been faced with concrete.

The 36-inch waste valve which has stood partly open and could neither be opened or closed since the 1912 typhoon was opened and successfully closed on November 29 by removing the stuffing box. It washed out 6 meters of mud, rock, bamboo, and coconut logs and no difficulty was encountered in closing the valve.

### ILOCOS NORTE PROVINCE.

A provisional bridge crossing has been provided for the Laoag River which is carrying the heavy truck traffic in safety. The cost was approximately ₱500, which is about what the balcero force would have cost for nine months. It is estimated by the truck companies of Cu Chatco, Cu Joco, and La Protectora that the crossing is saving them an expenditure of ₱8.40 per day. This is probably small in comparison to the saving to the general public. Similar crossings have been installed for the Badoc, Bacarra, Dingras, and Piddig Rivers.

It is now possible to travel from Laoag to Bangui by motorcycle without dismounting except at the Buraan ferry.

The province is to purchase a new Buffalo Pitts road roller from the Bureau in the near future.

Asphalting the damaged sections of the first-class road has been started in the municipality of Batac.

Asphalting the overflow section of the Laoag–San Nicolas Road will soon be instituted. As extreme high water will probably be 3 meters deep over this section, I believe the result of this project ought to be of special interest to the Bureau engineers.

### ILOCOS SUR PROVINCE.

Construction work in this province for the last three months has been centered on the Vigan–South Road and on the Tagudin diversion.

The road through the municipality of Santa Maria, part of the Vigan–South Road located in kilometers 31 and 32 with a length of 680 meters, is being reconstructed to a first-class condition. The surfacing consists of 13 centimeters of big pit coral for first course, 7 centimeters of crushed rock for the second course, and 2 centimeters of small coral for the finished course. The coral costs ₱1.80 per cubic meter, and is hauled from the Sosó Beach, a distance of 3 kilometers. Two hundred meters of this section is to be asphalted. The first course is already laid and rolled, the second course is to be hard gravel from Banaoang, and will have the asphalt binder. The fill is about 20 to 30 centimeters above the old road, costing 30 centavos per cubic meter. The total cost of this work is to be reimbursed by the municipality of Santa Maria.

The washouts on the Candon diversion caused by past floods have been repaired, and the subgrade has been prepared to receive the surfacing. The first course consist of 13 centimeters of big pit coral from the Candon Beach at an average haul of 6 kilometers, costing ₱2.25 per cubic meter. The second and third courses are to be of crushed rock delivered on the road at ₱1 per cubic meter with an average haul of 3 kilometers. Rock is being quarried and crushed at ₱2.50 per cubic meter. There are at present 150 bull carts hauling coral to the road, and if this number is kept for fifteen days more the whole road should be metaled by the end of December, 1913.

All the irrigation ditches on the Candon diversion have been provided with 0.61-meter pipe culverts, 13 singles, 4 doubles, and 1 triple. Four streams have been spanned with coconut log bridges with bamboo floors. These provisional structures are to be replaced by permanent reinforced-concrete ones when more money is made available.

The fills on the north and south approaches of the Candon bridge are completed. This was done by scrapers and bull carts, costing 25 centavos per cubic meter, excluding surcharges.

From the non-Christian funds the provincial board appropriated ₱16,000 for the reconstruction of trails leading from the townships of Nagbuquel to Narvacan, Bató to Santa Maria, and Peñarubia to Bangued. There is appropriated ₱3,000 for each of the first two and ₱10,000 for the last project. Work on the first two (projects 48 and 47, respectively) was started at the beginning of December, while the last project is awaiting the approval of the Secretary of the Interior. These three trails will be 4 meters wide with 2 meters metaling and 1 meter shoulders.

The Narvacan–Nagbuquel trail is 6.5 kilometers long and traverses a rich sugar and level rice country, and crosses the Narvacan River at kilometer 5 in the barrio of Codoog. During the rainy season this trail is impassible for bull carts. The proposed new trail follows the old road to kilometer post No. 4. From here it diverts to the north paralleling the north bank of the Narvacan River and crossing at kilometer post No. 5. Grading costs 35 centavos per cubic meter. The surfacing consisting of coral costs ₱1.25 per cubic meter for kilometer 1 and ₱1.35 for kilometers 2 and 3. On kilometers Nos. 4, 5, and 6 gravel will be used, since the Narvacan River is near. Coral comes from Sulvec, 6 kilometers from Narvacan.

The Santa Maria–Bató trail is 4 kilometers long, following the old road located on the slopes of a range of low hills. Grading costs 30 centavos a cubic meter and surfacing consisting of coral costs ₱1.56 per cubic meter for the first kilometer. These trails lead into the townships of Bató and Nueva Coveta.

On each trail one-half kilometer is already completed. Work is very slow due to the scarcity of labor as the people are harvesting their rice. With the amount appropriated we do not expect to build the whole length, but the provincial board agreed to appropriate more money when the present funds are exhausted.

The Bangued–Peñarubia trail is 7 kilometers long and leads into the rich rice country of (Patoc) Peñarubia, Bucay, and San José. It follows the old road except at the foot of the Peñarubia Hill it diverts to the right to secure a 6 per cent grade, thus avoiding a steep 15 per cent incline on the present location. Crossing the San Matias Creek is very troublesome. Sleds carrying farm products have to be unloaded and carried across a foot bridge by hand. This creek is the main trouble of the through traffic between Peñarubia and Bangued. It has a width of 60 meters from bank to bank and a height of 12 meters from the bottom of the stream, the depth of the water being 2 meters in dry season. A wooden structure is proposed to be built across this creek. With this bridge and the trail completed the agricultural products such as rice, sugar cane, and tobacco grown in Peñarubia can be hauled very readily to the market at Bangued.

As soon as these trails are completed they will be a great factor in the development of the country they traverse.

The work on the Tagudin diversion is progressing very rapidly in spite of the fact that we have to bring the labor from Ilocos Sur. The people of Tagudin and subprovince of Amburayan would not work on the road. Grading is practically completed from the first large cut out of town to the river, a distance of 2.4 kilometers, including the big fills over the Ingot pipe culverts. From the saddle to the first large cut the road is graded and ready to receive the gravel.

## ILOILO.

The reconstruction of Calle Real has been, since the last issue of the Bulletin, one of the most important pieces of work undertaken by this office. It has been, and continues so, a very tediuos piece of work, due to the narrowness of the street, the heavy traffic, and the fact that in preparing the existing roadway for the first course of stone the heavy road roller was continually breaking through the old surfacing, forcing through it the original muck fill which underlies all of Iloilo; however, the work has been completed to the Plaza and is an excellent roadway.

In accordance with an agreement entered into between the city of Iloilo and Inchausti & Co., Calle Legaspi has been considerably widened and improved under the supervision of the district engineer. The walls of the old bodega owned by Inchausti & Co. were torn down and moved back on the new line of street and a rough rubble wall constructed from same back to the south line of Inchausti's property. In view of the increased width of street obtained, the entire expense of the repairs was borne by the city of Iloilo.

Several years ago arrangements were made for the purchase of the Lopez property leading from the Muelle to Calle Progreso, in order to open a new street from the Muelle through Progreso to the water front in the vicinity of Warner Barnes & Co. Only recently, however, was it possible to complete all details and begin the work. All houses were removed by the 1st of December and construction at once began. The street will be 17 meters in width and about 350 meters long, constructed throughout of broken stone, with concrete sidewalk and gutters. It is a continuation of the modern improvements along the Muelle and in every respect will be a credit to the city.

The Pototan market is rapidly nearing completion. The contractors have been considerably delayed on account of the shortage of lumber in the local market, but will undoubtedly complete the work within the time limit. It is unquestionably the most attractive looking market yet built in Iloilo. The bids for the type "A" tiendas proved unsatisfactory and the work was authorized by administration under the direction of the district engineer. All materials are ordered and the work has been started.

The Santa Barbara market and tiendas have been completed and opened to the public. The latter were constructed by the local firm of Lambert & Co. in record time. The contract was signed on the 29th day of August for completion by December 28. The work, however, was completed on November 10, and tiendas turned over to the municipality on the same date.

During the rainy season all construction was abandoned on the new roads from Dueñas to Lambunao Viejo and from Lucena to Jalaud. Work has again been resumed, however, and it is hoped to complete both in the next six months.

Plans have been received for the 20-room schoolhouse to be built on Calle General Luna in the city of Iloilo. The full appropriation has as yet, however, not been received by the provincial treasurer and the work is temporarily delayed.

The second-class roads from Pototan to Dingle, from Cabatuan to Janiuay, and from kilometer 16 to Miagao on the Iloilo-San Joaquin Road, on which repairs have been under way for some time, are wonderfully improved and with a reasonable appropriation for the new year can easily be converted into first-class roads.

Bridge 9.8 on the Manduriao-San Miguel Road, a new 15-meter arch, has been completed. A. Buchanan was the contractor. The bridge is an excellent piece of work and it is the intention to greatly improve the road to San Miguel with a view toward extending it at an early date to Leon and Alimodian.

Foundation tests have been made on the site of the new customhouse and forwarded to the Consulting Architect. It is hoped to advertise the new customhouse at an early date.

A survey and estimate has been made for the construction of the "Ice Plant Road." This road connects the road leading from Forbes Bridge to the railroad station with the bodegas lying across the river from Iloilo proper. Approximately 5,000 cubic meters of rock will be used for fill and a temporary timber bridge 20 meters in length will be constructed.

The work of filling in the streets around the market buildings at Jaro is completed. Gravel was used for surfacing.

The Iloilo-Maasin Road near Cabatuan has been badly damaged by the Tigum River. The river shifts its channel over the valley with each freshet, and annually destroys several kilometers of surfacing and road bed. A survey has been made between kilometers 21 and 27 along the south bank of the Tigum River, passing about 1 kilometer south of Cabatuan. This line will avoid bridging and be out of reach of the river altogether. It is 5,582 meters long and only 168 meters longer than the present road. The first kilometer follows the San Miguel Road, thence through a short 7-meter cut to the Tigum River Valley, thence for 1 kilometer along the hillside, and the remainder of the distance along the level bench land at the south side of the valley over which the alignment is nearly straight and very little grading will be necessary. It is hoped to provide funds for this work in the new year's budget. As this road passes through an important district, it should be open to traffic the year round.

An appropriation of ₱2,500 was made available for the construction of an addition to the provincial building to be used as a storeroom for the provincial treasurer. Plans prepared by the district engineer were approved by the Consulting Architect and the work advertised. The lowest bid received proved to be about ₱800 over the estimate and the work was undertaken by administration. The building will be completed about the 1st of February.

## ISABELA.

The construction of the Cabagan–San Pablo Road was completed November 23, 1913, having a total length of 3.6 kilometers. A saving of ₱500 per kilometer, or 12 per cent of the original estimate, was effected by the employment of contractors in the haul of gravel. The completion of this road has created a considerable demand for regulation wide-tired carts, which have been ordered and upon arrival will be distributed.

For lack of funds, the construction of the Echague–Angadanan Road cannot be finished this year. Seven kilometers out of the 9 kilometers proposed this year were completed. This road crosses the Ganano River, which is infested with crocodiles, some having been caught measuring 3 meters and more in length.

In spite of the rainy weather, the construction of the Rugao bridge is advancing fast. One pier is already finished and the rest of the substructure will be completed by the middle of January, 1914.

The road and bridge program of Isabela Province for 1914 is planned so as to permit complete traffic between Nueva Vizcaya and Naguilian, Isabela, a town 18 kilometers from Ilagan, the capital of Isabela, and from Ilagan to Cagayan Province, which will greatly help the mail service. The mail can then be carried on horseback from Tuguegarao to Ilagan in eight hours during the entire year, while it now takes, by water, from twenty-four to thirty-six hours between these towns.

The survey of the Ilagan–North Boundary Road joining the Tuguegarao–South Boundary Road of Cagayan Province has been completed and the plans, profile, and estimate are now finished ready for approval. The road has a total length of 50½ kilometers, traversing the towns of Ilagan, Tumauini, Cabagan Nuevo, and San Pablo. Tobacco, corn, rice, and other minor products are semiannually produced in these towns.

The construction of the Cabagan–San Pablo Road produced an enthusiasm among the people of the barrio of Casibarag, Cabagan Nuevo, unequalled in the province. The provincial road through their barrio, which forms one-half of the Cabagan–Santa Maria Road, was constructed by them without the financial aid of the province. The people of the barrio divided the 3 kilometers of road in their barrio equally and built it, taking as a sample the Cabagan–San Pablo first-class road. The capataces of the Cabagan–San Pablo Road have helped the people by advice and suggestions as to the best methods of road construction.

## LAGUNA PROVINCE.

Owing to scarcity of funds, it has been necessary to reduce the camineros by half, giving each one 2 kilometers in place of 1. The force will be recruited up to full strength again as soon after New Year as the receipt of funds may permit.

One kilometer of road from the provincial building to the railroad station and toward the lake landing place has been surfaced with Los Baños stone, and the provincial board has designated it first class and put it under caminero maintenance. The beach road and 1½ kilometers of the Santa Cruz–Pila Road will be surfaced early next year, thus completing the provincial roads in and immediately surrounding Santa Cruz, the provincial capital.

The Calamba–Vigaa Road is passable for automobiles at present, though rough. A repair gang will be put to work on it immediately after New Year to fix up the worst places. The Lumban–Mavitac Road held up through the rainy season fairly well and is passable for carts and carromatas throughout its length. The San Pablo–Nagcarlan Road during the latter part of the rainy season was practically impassable but is now open to wheeled traffic, and will be open for automobiles by the latter part of January, if the weather continues good. It is hoped that money may be available for the making of this road into a first-class road before another rainy season as it is impossible to keep it open to traffic during the latter part of the rainy season on account of the very heavy traffic, and, owing to the unusually large coconut crop now on the trees to be harvested during the next year, the need of a good road will be greater than ever.

We have had considerable trouble with anay or white ants in the temporary truss bridge across the San Cristobal River at Calamba, kilometer 54 of the Manila–South Road, where they secured a lodgement in and seriously damaged the lower chords before they were discovered.

Creosote was first used, ½ inch holes being bored into all of the affected parts and kept filled with the creosote. Some of the boards of which the chords were composed were so badly damaged that it was necessary to replace them with new boards.

Not entirely satisfied with the success obtained by the use of creosote, it was decided to try an English preparation, Atlas Preservative "A", which was found to be superior to the creosote, at about one-fourth the cost. By its use the bridge has been entirely freed of the pest which apparently it was impossible to do with creosote.

Soon afterward anay were found in the court records on file in the judge's room in the provincial building. The records were, with the judge's permission, burned and the anay tracked to a hole in the cement wall connecting presumably with the hollow columns outside the walls. This hole was stopped up with cement mortar but the next day it was found that the anay had bored through the mortar before it had set, and had started another trail to the woodwork. The hole was again cleaned out and sealed up with mortar in which preservative "A" had been mixed and to date, some three weeks later, no further sign of them had been noted.

A block of nine 4 by 4 meter tiendas is being constructed as a part of the Santa Cruz market from the balance left after the market building proper was completed. The work is well advanced and they should be ready for occupancy by the middle of January, 1914.

The market building, 18 by 38 meters, was completed December 20, 1913, and is now occupied, although the grading of the lot has not yet been completed. It appears now that after the grading is completed there will still be a balance available for the construction of a block of five 4 by 4 meter tiendas.

The construction of the Nagcarlan schoolhouse, Bureau of Education plan No. 10, has been suspended pending the receipt of roofing material. All the concrete work has been completed, and the window frames and roof trusses are in place. The roofing material is now in San Pablo awaiting transportation to Nagcarlan, which is almost impassible at present on account of the condition of the road.

Bids for the construction of the Laguna high school, being 16 rooms of the Bureau of Education standard 20-room plan, were opened on November 25, 1913. All were rejected on account of being too high and the work is being done by administration. Material is being received, and work on the footings has just begun.

Bids for the construction of the Rizal Memorial School were opened on December 9, 1913, and were all rejected on account of being excessively high. The work will be done by administration and will be started early in January, 1914.

Bids for construction of a second market, 30 by 43.5 meters, and a block of six 4 by 4 meter standard tiendas were opened on December 20, but, being considered too high, were rejected and the work will be done by administration.

The output of the Los Baños quarry for the quarter ending September 30 was 4,254.5 cubic meters and sold for ₱11,471.37. It is estimated that the output for the quarter ending December 31 will be approximately 5,375 cubic meters and will be sold at ₱2.20 per cubic meter for ₱12,925.

The car service during the month of December has been very poor, and the output has been considerably reduced in consequence. Practically all of the stone is now being shipped to Tayabas and the Railroad Company is unable to handle it promptly over the Calamba–Luta grade.

## LA UNION.

Surveys have been completed for a relocation of 2.67 kilometers of the Naguilian–Baguio Road (the "Naguilian Trail") at the Ripsuan River crossing. Heretofore the river has been crossed by fording, at low water stages, and by bamboo ferry when the water was too high to ford.

The proposed change contemplates the construction of a suspension bridge supported by two concrete piers in the stream bed 300 feet apart. The height to which the proposed piers reach will be to 1 meter above extreme high water elevation; upon them will then be constructed wooden towers to support the cables for the suspension bridge. It is proposed that not only the portion of the cables between the towers support the central span of the bridge, as is the case now with all suspension bridges on the Benguet Road, but that the shore spans also be supported from the shore ends of the cables, making a bridge whose total length will be approximately 430 feet.

The proposed new road, instead of crossing the river valley in the widest place as formerly, and following up a side cañon to gain distance for an easy grade, will follow up the river valley itself to a point where the valley is narrower, with bluffs on each side of the river at the proposed crossing.

After leaving the bridge on the Baguio side the proposed road works its way on a 6 per cent grade to the top of the bluff, follows a low ridge on a gentle grade to the foot of Palali Hill, back a short distance from the river, then, by a "zigzag" along the side of this hill, works its way up the hill to the old "Naguilian Trail."

When completed, this road will not only be shorter, but the grades will be easier and more uniform, and the crossing can be made over the high bridge throughout the typhoon season as well as during the dry period, the latter being the only period at present during which the Ripsuan crossing can be made.

The valley section of the Naguilian–Ripsuan Road, kilometers 18 to 24, inclusive, has just been completed as first-class road. The metaled portion of this road is 2.50 meters wide, but the shoulders, the subgrade, and the right of way are all of the Bureau of Public Works standard width. It is the intention in the future to widen this road to full 5-meter width, and to continue the metaling through the foothill section to the Ripsuan River, 2 kilometers farther. Before the foothill section can be metaled, however, the grades will have to be made easier and the curves less abrupt. Formerly, this 2-kilometer section of road followed the stream bed of the Ripsuan River; now the road is placed on the side of the bluff north of the river and at an average elevation of 15 to 20 meters above ordinary water level.

On December 16 bids were advertised to be opened for the construction of one market and one block of tiendas at San Fernando. The market is to be of standard type, reinforced concrete with galvanized ingot iron roof, 24 by 42.8 meters in dimension. The tiendas will comprise one block of eight 4 by 6 meter reinforced concrete, with galvanized ingot iron roof. However, there were no bids submitted.

For the construction of this market and block of tiendas ₱31,500 have been appropriated of which at present about ₱28,500 remain after paying for the site and other incidental expenses.

Appropriation of funds to the amount of ₱15,500 has been made for the construction of an 18 by 38 meter standard type, reinforced-concrete market building at Naguilian. Bids were advertised to be opened December 24.

Six kilometers of first-class road have just been completed at Bangar, the northernmost municipality of the province. This road is 4.27-meter metaled section (gravel), with standard shoulders, slopes and right of way, and extends from the provincial boundary, 4.6 kilometers north of Bangar, to 1.4 kilometers south, toward Balaoan, this being the approved route through the interior of the province from Bacnotan, instead of following the old road along the sea coast by way of Luna. Work is to be begun immediately upon the subgrade for a first-class road from Balaoan, in the interior, to Luna on the coast, thus connecting Luna with the road from San Fernando to the province farther north.

Work has been started upon a cart trail from Rosario to Rabon. Rosario, the seat of government for that municipality, is 12 kilometers from the nearest railroad station, the barrio of Rabon. In the rainy season it is impossible for vehicles to cross the Bued River at Camp One, only 3 kilometers from Rosario, and as the Manila Railroad Company takes up its Camp One line during the rainy season, there is no outlet anywhere from Rosario, except footpaths over the hills to Rabon.

Before the next rainy season sets in, it is hoped to have a passable trail, such that loaded carts may pass over the road throughout the year.

### LEYTE PROVINCE.

Work has been started on the following six concrete pile bridges on the Maasin–Inopacan Road:

Pandan kilometer 52.5 (three 7-meter span), Panaliwad on kilometer 52.3 (three 6-meter spans), Bulacan kilometer 52.0 (five 6-meter spans), Hindang kilometer 48.0 (four 6-meter spans), Pamipion kilometer 47.4 (two 6-meter spans), and Binabulan kilometer 43.4 (two 7-meter spans).

These are the first bridges of any consequence to be undertaken on the west coast.

As the locality is so isolated, with no ports or other means of communication, and the distance from Tacloban so great as to render supervision difficult, it was desired to do this work by contract and efforts were made to interest contractors.

The lowest total bid received was ₱55,850 which was 25 per cent in excess of the total estimate of ₱44,503.20 figures on same basis as contractors bid, or ₱52,400 including surcharges and inspection. It was decided to do this work by administration.

The greatest difficulty that confronted us was the transportation of about 280 tons of steel, cement, etc., from Manila and the transfer from Tacloban to Contra Costa of equipment, old form lumber, etc., approximating 80 tons.

Letters were written to all prominent shipping firms for terms, time allowed for unloading, etc., and negotiations were entered into with the local Chino houses for transporting the equipment from Tacloban to Contra Costa.

As there are no wharves and the steamers can not come close to shore the unloading was a serious problem.

After considerable correspondence a steamer was obtained from the Tabacalera Company to bring the material from Manila and a large schooner with an auxiliary engine was chartered from the local branch of Ortega Hermanos to carry down the equipment. The sailing dates were so arranged that the schooner would arrive shortly before the steamer so that the large sampans of about 5 tons capacity each, which the schooner towed, could be used to unload the steamer. As these cost ₱5 each per day and the schooner ₱75 per day it was desirable to get rid of them as soon as possible. By working night and day shifts the unloading of the steamer was accomplished under thirty-six hours, over which time we would have had to pay ₱250 per day for the steamer.

Getting plant and material on the ground cost ₱2,500 which was better than anticipated.

Now piles are being driven on Bulacan bridge and at the present rate of progress it is confidently expected that these six bridges will be completed at considerably less than the estimated price or probably 30 per cent less than if done by contract. They should be completed in eight months from time of starting.

The Pastrana school, a Bureau of Education standard plan No. 3 (revised) school building, has just been completed by administration at a cost of little less than ₱8,000.

The estimated cost was ₱9,108, but as only ₱8,000 was available it was decided to go ahead, with the idea of getting an inclosed building, omiting windows, partitions, and ceiling.

This building is situated in one of the most difficult places imaginable to which to get material.

First, material had to be taken to Malirong, a distance of 14 kilometers, by automobile and then up a river so tortuous that it takes thirty-six hours for a baroto to go from Malirong to Pastrana, which are not over 9 kilometers apart in an air line. The trail, however, is one succession of mud holes over which transportation is out of the question.

Notwithstanding these difficulties, the building was fully completed within the ₱8,000 appropriated.

The Leyte school, a Bureau of Education standard plan No. 3 (revised), situated in the central barrio of Leyte has been completed at a cost of ₱8,000. The estimate for this building was ₱9,200. The lowest bid was ₱7,832 which with the surcharge would make a total ₱8,693.50 without inspection charges. As there was only ₱8,000 available this school was also started with the idea of omitting windows, ceiling, and partitions, the work being done by administration. This is also an isolated project, Leyte being situated on the northwest coast of the province at the head of a bay about 14 miles long and out of the way of steamers. Also steamers are obliged to anchor quite a distance out on account of the shallow water and there is over a kilometer haul from the beach to the school site.

By advertising for bids for transportation, taking advantage of the best one offered, and first getting all material at Tacloban before sending men to the job or shipping anything, it was possible to get all material to the site at a cost of about ₱400.

The building is now fully completed, including windows, partitions, ceiling, etc., at ₱1,200 under the estimate and about ₱900 less than it would have cost by contract.

The total cost of either of these two schools, including surcharges, as compared with the only two former buildings of this size plan constructed in Leyte is ₱800 less than Hilongos and ₱2,000 less than Hinunangan, notwithstanding the fact that these (Hilongos and Hinunangan) were in more accessible locations and were of the unrevised plans which are cheaper than the revised. They were done by contract for ₱8,300 for Hilongos and ₱8,150 for Hinunangan, but the surcharges brought their totals up to ₱8,818 and ₱8,903, respectively.

There was also ₱1,228 worth of material donated to Hinunangan making it ₱10,141.

The Anahawan school, a Bureau of Education standard plan No. 2 school, has been completed by administration at a cost of about ₱4,600 with about ₱500 of donated lumber. Estimate, ₱5,690.21. Lowest bid, exclusive of surcharges and inspection, ₱6,480.

The Himatagon school, a Bureau of Education standard plan No. 2, is under way and will be completed early in January. Work is being done by administration.

Work has been started on the Kawayan school situated on the Island of Biliran. This is an old-style No. 5 plan of the Bureau of Education. The concrete work was completed in 1911 at a cost of ₱2,800. The remaining work is estimated to cost ₱7,750. The work is being done by administration.

Advertisements for bids have been placed for standard No. 7 (revised) school at Burawen.

The Digahungan bridge at kilometer 29.2, Palo–South Road, has been completed by administration at a cost of ₱6,200. This is a two 7-meter structure on 11 and 10 meter concrete piles. Its estimated cost was ₱7,500.

The Kiling bridge, three 6-meter spans, at kilometer 24.4, Palo-South Road, has been completed by administration at a cost of ₱6,300. Estimate, ₱7,400.

These two bridges were built at a total of ₱2,400 less than their total estimate. Their total cost per linear meter was ₱390, including surcharges, or ₱353 per linear meter omitting surcharges.

Work on the construction of the Burauen–Dulag section of the Palo–South Road has been discontinued until after the rainy season.

The 5-ton White truck with the demountable body, recently purchased, is in daily use and is proving a very important factor in reducing the cost of various projects.

### MISAMIS.

Good progress has been made in the construction of standard and pipe culverts, 31 standard culverts from 1 to 5 meters and 25 pipe culverts, both single and double, having been constructed during the past year. On the Tinao–Bukidnon Road, through a mountainous country, it was deemed inadvisable to attempt the construction of concrete culverts, due to the shortage of gravel, sand, and water, and ingot-iron culverts were installed which have proved very satisfactory. Care must be taken in excavating for the bed, and the earth should be tamped in on both sides of the culvert at the same time so that it will lay in a solid bed, thereby avoiding any chance of buckling.

The Cagayan–West Road has been graded from the Cagayan River to Opol, a distance of 10 kilometers. About 1 kilometer of this road runs through salt-water flats and a fill of 1.40 meters in depth, 9.20 meters in width at the top and 14 meters at the bottom, was made, using carabao and drag scrapers in addition to wheelbarrows. A native foreman was in charge and the average cost of this fill in place was ₱0.58 per cubic meter.

The full 15-meter right of way on the Cagayan–Dock Road, the most important road in the province, has been secured, and the roadbed and surfacing widened to accommodate the increasing traffic. The property owners along the road had encroached upon the right of way until in many places it was only 5 or 6 meters wide, but fortunately no serious difficulty was encountered as it was found that Señor Cruz was general foreman in Misamis in 1882 and personally superintended the setting of the right of way stakes, and laid out a 12-meter right of way, not including the berms, slopes, and ditches.

Unusual difficulties have delayed the completion of the Jimenez bridge, but the last abutment should be finished by December 31, 1913, and it is hoped to complete and throw the bridge open to traffic in the near future.

The surfacing of 7 kilometers of the Misamis–Loculan Road has been completed. There are about 3 kilometers to construct in order to complete the road to Tudela. This will tap a large, rich rice section and furnish an outlet for the produce of the surrounding country.

### NUEVA ECIJA.

Two bridges and nine reinforced-concrete culverts have been completed on the Gapan–Bulacan section of the Manila–North Road.

Three and one-half kilometers of road have been completed on San Isidro–Pampanga Boundary Road and will be declared first-class January 1, 1914. Work on this road has been under the direct charge

of a Filipino foreman and results obtained are exceedingly gratifying. The subgrade, though constructed in the rainy season and in a low country, where the fill had to be taken from rice fields, which were under water, cost less than ₱0.50 per cubic meter.

The surfacing for this road was taken from Rio Grande and transported in carabao carts to the road. The carts, including carabao and driver, were paid ₱2 per day, and it cost ₱0.39 per kilometer per cubic meter to deliver the gravel on the road with an additional cost of ₱0.08 per cubic meter for spreading.

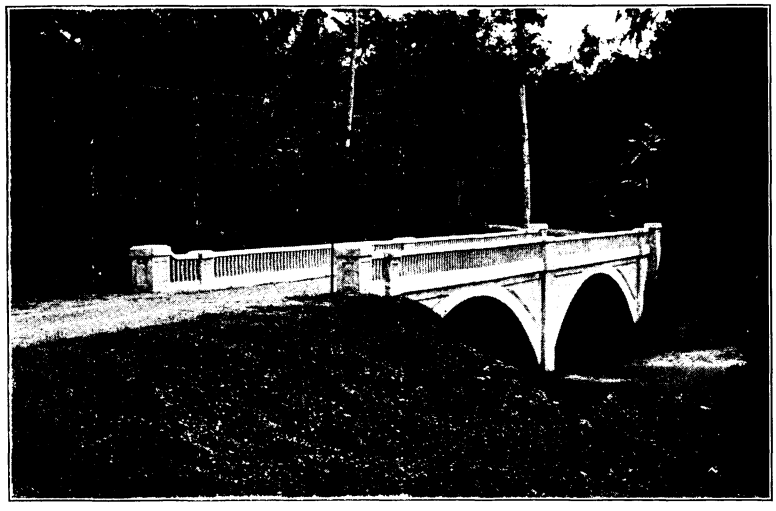
It is expected to continue work on this road during the coming year with the hope of connecting the Province of Nueva Ecija with Pampanga in the shortest time possible.

Two collapsible bridges have been constructed on the Manila–North Road—one on the Peñaranda River, Gapan, Nueva Ecija, and the other on the Rio Grande, Cabanatuan, Nueva Ecija; 22 kilometers of road between Gapan and Cabantuan has been repaired and this road is now open for automobile and other traffic from Cabanatuan to Bulacan near San Miguel de Mayumo.

The contract for the construction of a 20-meter reinforced-concrete bridge over the Minatola River, Santa Rosa, on the Manila–North Road, was let to Mr. M. E. Martin, and the structure is now about 40 per cent completed.

The contract for the erection of the steel for the Minatola, Tabuating, and Baliuag River bridges has been let to the Atlantic, Gulf and Pacific Company, and steel is now being delivered in the province. It is expected to have these structures completed by April 1, 1914.

The road from Baloc to Pangasinan boundary via San Jose and Lupao has been repaired and is now open for automobile and other traffic from Cabanatuan to Pangasinan boundary.



Matabang bridge with spandrels, Occidental Negros.

By January 1, 1914, the province will have 50 kilometers of first-class road, 22 kilometers of second-class road, and 34 kilometers of third-class road, all of which will be passable for automobiles and trucks during the entire dry season. A garage has been opened in Cabanatuan and automobiles and trucks are now making daily trips from Cabanatuan to San Isidro, Cabanatuan to San Jose, and from Cabanatuan to San Juan de Guimba. The province is making every effort possible to connect Cabanatuan with Cuyapo, Lupao, and San Jose with an automobile road.

For the coming year, the province will have ₱239,000 of her own money to be spent on the construction of roads and bridges and, with insular aid, this province will be able to complete an excellent road system within two years.

Seven thousand five hundred pesos has been received for the construction of a standard No. 3 school building in the municipality of Talavera, Nueva Ecija. Materials for same are now being delivered and construction will be commenced within a few days.

## OCCIDENTAL NEGROS.

The plant of the San Carlos Milling Company has been completed and grinding will begin in January. As an example of rapid construction it is well worthy of admiration. The mill, as designed, is composed of two units, only one of which has been constructed. The plant consists of a 1,400-foot wooden pile dock (temporary, to be replaced with concrete), an 11-roll mill, suitable power plant, with steel stack, machine shop and camarin, all constructed of skeleton steel frames with galvanized-iron sheathing. There are also houses for the manager, foreign and native employees, and a "club" for transient bachelors. Residences are constructed of redwood and are fitted with running water and modern plumbing. A steel tank on a skeleton tower furnishes artesian-well water under pressure for domestic and fire protection purposes. Electric lights and cold storage are provided by a suitable small plant.

A narrow-gauge steam railroad (using redwood ties and Baldwin locomotives) will bring the cane to the mill. Several plate-girder bridges were built and about 15 miles of track will be required to operate the mill to capacity. A telephone line to the several haciendas will permit constant regulation of the movements of cane trains, etc.

The whole plant is strictly modern and the operation of the mill will be closely watched by all the sugar-growing hacienderos of the Visayas.

The San Carlos district is isolated to a great extent by the mountains which form the geographical backbone of the Island of Negros. It is small compared to the rolling plains of the La Carlota district, and the successful operation of a modern mill, one of the largest in the world, in so small a producing area cannot but stimulate the installation of advanced methods throughout the province.

The sugar-grinding season is now well under way throughout the province and demonstrates very forcibly the necessity for more equable distribution of the population of the Islands, or the inauguration of methods to induce a laboring class to settle here. Hacienderos, by advancing money, induce a small number of laborers to come from Panay during the grinding season. Such laborers invariably return to their home provinces when the milling is completed.

With the road-building season coincident with the time of milling, public works must suffer, as labor is scarce and high priced. For the first time in years, the caminero force remains practically complete, as the ruling that accepting an advance from hacienderos (which would require the man to go to work on the hacienda on demand) would operate to prevent their reinstatement in the service has deterred them from following their usual custom.

Placing the camineros in uniform has also produced in them a feeling of unity, an "esprit de corps," which bids fair to bring vast improvement in their work and desire to remain in the service.

An appropriation has been made to construct a road from Binalbagan River to Himamaylan, a distance of approximately 12.5 kilometers. The first kilometer and a half will require surfacing at once, as the soil is a red clay, but the remainder will be constructed as an earth road of standard cross section, deferring the surfacing until funds permit.

The characteristic high winds of the north monsoon and extremely dry weather are sweeping the roads clean, causing raveling and "pockets." The tremendous tractive force of heavy trucks and automobiles, which constitute the major portion of traffic here, quickly loosens the binder and the winds do the rest. To one who sees real money in each cloud of dust, the dry season spells a period of waste and destruction.

The fill at Magsungay bridge has been completed and surfacing is now being placed. Approximately 11,000 cubic meters (loose) of fill were placed. The first of the fill was constructed by day labor and the remainder by "paquiao."

The advantage of doing work by the latter system was so obvious that laborers are being encouraged to paquiao whenever the nature of the project will permit it.

The fill costs ₱6,900, including the cost of surfacing the north approach, planting a portion to Bermuda grass, supervision, and surcharges.

The material was a hard sandy clay, difficult to loosen and very heavy. As a result, day labor was very unsatisfactory and on the paquiao the men made double the ordinary wage by having their women and children loosen the dirt the night before.

La Carlota market building and tiendas were completed October 11, 1913, by the contractors, the Insular Construction Company. The work is very creditable to the builders.

A 30 by 43.50 meter, San Roque type, main building was constructed and one block of seven double tiendas, closed type. This leaves the second main building and seven blocks of tiendas for future construction, as the needs of the town demand and funds become available.

The cost of the work was as follows:

| | |
|---|---|
| Miscellaneous (advertising, etc.) | ₱16.98 |
| Contract and extra work (labor and materials) | 29,871.65 |
| Surcharges | 4,368.63 |
| Total | 34,257.26 |

The extra work done consisted of 993 cubic meters of filling, costing ₱1,986; 3 cubic meters of concrete, costing ₱105; and minor additions to tiendas, costing ₱36.06.

As this is the first modern market constructed in Negros Occidental and as the conditions are such as to require a continual "market" rather than one special day each week, the results obtained from its operation will carry much weight with other municipalities in determining future construction projects.

### ORIENTAL NEGROS.

Two schoolhouses have recently been completed, one at Sibulan and one at Larena. The Sibulan school is a 4-room building, Bureau of Education plan No. 5. The Larena school is very similar, both in size and shape, but is an old building reconstructed. The roof of each has been painted with a first coat of rust inhibitive primer and a second coat of red.

Bids were opened on December 12 for the construction of market buildings in Dumaguete and Bais. C. V. Powers of Iloilo was the lowest bidder in each case and will probably be awarded the contracts. His bids were as follows: For a 24 by 42.80 meter, type "A", market in Dumaguete ₱16,540, and for a 15 by 39 meter, closed court market in Bais ₱9,845.

The removal of the wrecked concrete arches of the old Ocoy bridge is well under way. Two-thirds of the cement for the new abutments is on hand. Lumber and piling for cofferdams and false work are expected in January. All construction and erection of steel is to be done by administration.

A number of artesian wells will be drilled in this province during the ensuing year. One of the Bureau of Public Works deep-well rigs arrived the latter part of November and is now hard at work on the first well. This is located in Dumaguete on the site of the new market.

### PAMPANGA PROVINCE.

Active arrangements are being made to secure all the materials for the telephone central building and construction will begin within a very short time. The building is to be of reinforced-concrete foundations, walls, and floor slabs. The framing lumber for the roofing is to be covered with No. 1 selected, approved red cement roofing tile. Framing lumber is to be used also on other structural work. In the framing of all doors, windows, paneling, etc., finishing lumber is to be used. This building will stand on a prominent spot back of the provincial building. The size is 5.10 by 5.10 by 10.53 meters, and the amount available for this purpose is ₱2,600.

The alteration and addition to the provincial jail building is now being done by administration and work is progressing rapidly. New plans had been prepared by the Consulting Architect with alterations on the existing concrete building by placing a new tile roof on steel trusses. The present flat concrete roof covered by asphalt has been the cause of considerable complaint on the part of the court officials and other occupants due to leakage during rainy seasons. The new roofing system will no doubt remedy the whole situation. The new plans provide an extension of 7.25 by 9.75 meters in front of the present court building. This will almost double the size of the present office rooms. Considerable help is obtained from prison labor and it is contemplated that upon the completion of the building part may be saved from the amount of ₱18,000 appropriated for this purpose. The new, as well as the existing structures, footings, piers, walls, floors, slabs, columns, and girders are of reinforced concrete. All window and door frames and ceiling joists are of wood. Door and window sash to be glazed with first-quality shell. The ceiling for the second story is to be covered with steel ceiling. The work is about 15 per cent completed.

Repairs on bridges Nos. 2.3, 9.8, and 10.9 on the San Fernando–Lubao Road are under way. This work consists simply in replacing the old wooden floors with new ones, with modifications in the I-beam stringers and railings. All of the other bridges along this section are in excellent condition.

The second-class roads are being surfaced to meet the needs of traffic. Construction of wooden-truss bridges to replace existing provisional bridges has been advertised, and same will be started in the near future. Extreme difficulty is encountered in traveling over the unsurfaced roads of this province during the rainy season and some of them are being surfaced with gravel to make them passable throughout the year.

The river cutting on its bank at sharp curves, specially during the rainy season, has made several portions of the levee very narrow. With the very small amount of money on hand only minor repairs have been made to make it passable all the time. As a roadway, this levee is graded up to the highest water mark and the grade is uniform almost all the way from the south boundary of the province up to the town of Arayat, a distance of about 40 kilometers, and during the dry season it is a delightful road for traffic or even automobiles.

Surfacing on the San Fernando–Arayat Road has been resumed and nearly a kilometer has been completed since the beginning of this dry season. Considerable progress is contemplated from now on as sufficient surfacing material is deposited near the work. Hard broken stone is used.

A feature in the line of educational improvement in this province is the Guagua intermediate school building recently constructed in accordance with the standard plan No. 10 of the Bureau of Education at a cost of ₱19,300.

The Guagua market is about 90 per cent completed and it will be ready for occupancy at the beginning of the summer. The construction is done by administration with the exception of labor which has been awarded to a local contractor.

### PANGASINAN.

A special allotment of ₱10,000 has been received for river control at the site of the Calasiao market. A pile and rock revetment is to be used, work starting immediately.

Plans have been completed in the district office for the reconstruction of the Hermosa Dike. These plans call for reinforced-concrete block paving for both ends of dike, the blocks being connected with chains.

Test borings have been finished for the Bayambang bridge.

The Bayambang waterworks has been extended during the past two months so as to serve an additional street. This system, as well as that of Camp Gregg, is furnished water by an artesian well having a head of 123 feet and a flow of 500 gallons per minute. All the important street corners have faucets and fire plugs and a number of houses are also connected to the system. There is a municipal bath and wash house in the immediate vicinity of the presidencia. An automatic flush sewerage system is being constructed at present to serve the public buildings and to remove excessive rainfall during the wet season.

Construction of a standard 3-room school building has been started in Bayambang.

Money has just been received to build a standard 7-room school building in the municipality of Malasiqui.

Due to its destruction during the rainy season of this year, the Mangaldan bridge has been reconstructed and traffic through to Baguio is now uninterrupted.

There are now in this province a total of 141.7 kilometers of first-class and 213 kilometers of second and third class roads open to automobile traffic. There are five distinct hunting grounds touched by these roads, which abound in deer. One of these is also noted for its wild carabao hunting.

Passenger automobile trucks have been placed on the Lingayen–Alaminos Road.

### PROVINCE OF RIZAL.

Work of reconstructing Junction–Montalban–Taytay Road is advancing favorably, considering the shortness of labor. On account of the rice harvest being on, it has been impossible to maintain a sufficient gang. From Cainta to Junction, the alignment is being straightened and the curves eased to a considerable extent.

The Golf Club Road which connects the Golf Club with the Manila–North Road, a distance of approximately 600 meters, has been completed first class.

The construction of Antipolo market is progressing favorably and will be completed within the next month. The contractor, A. Gablei-Gambert, has asked for an extension of time, as he was delayed in the beginning of the work on account of some question with regard to the exact location of building or the grounds.

Plans and specifications for the Antipolo sanitation system have been received by this office, and same is being advertised for bids.

The Talim powder magazine is about 60 per cent complete. The contractor says it will be finished well within the contract time.

Reconstruction work on the Manila–Novaliches–San Jose Road is about to be drawn to a close. A little more work is still to be done on the ditches and culverts.

### SAMAR PROVINCE.

The contract for the construction of six reinforced-concrete pile bridges and one two-span slab and girder bridge on the Calbayog North and South Roads has been awarded to J. E. Ainsworth for ₱61,621.50, the province to furnish reinforcing steel. Active construction on these bridges will be begun in January.

From January 5 to 9, inclusive, the Province of Samar will hold its first annual exposition and carnival at Catbalogan. Great preparations are being made to make this event a notable one in every respect. All municipalities are forwarding exhibits, and the schools throughout the province will exhibit all the different classes of industrial work. The Bureau of Public Works will display an exhibit of views, transparencies, and models illustrating all types of public works throughout the Islands. In addition to the exposition, there will be a carnival city boasting of merry-go-rounds, circus, cinematograph, and the usual line of side shows.

Plans have been prepared in the office of the district engineer for a grand stand to be erected at the Catbalogan athletic field. This project is being pushed with all speed in order that the grand stand may be used during the athletic meet to be held at the time of the January exposition and carnival.

Owing to lack of funds, work on the Guiuan–Salcedo Road was suspended in November. The construction of this third-class road was undertaken primarily as a relief measure, as the severe typhoons of the past year destroyed the entire coconut crop in this section and left people practically without means of support. Grading on 15 of the 17 kilometers of road was entirely completed and the remaining 2 kilometers cleared and made passable for carts. In kilometer 10 a 400-meter causeway was constructed across an arm of the sea, a wooden pile bridge in the center providing an opening for the flow of the tide. The coral rock used in this causeway was "paquiaoed" for 50 centavos per cubic meter.

Bids were opened December 1, 1913, for the construction of a standard market building and tiendas for the municipality of Calbayog. As the only bid received was considerably in excess of the estimate of the district engineer, it has been recommended that the work be done by administration. The site decided upon for the market is located upon a low mud flat partially covered by high tide, and approximately 1,800 cubic meters of extra filling will be required.

A soft sandy soil necessitated an increase in the size of the footings of the Catbalogan central barrio school. Work on this project is progressing rapidly. The building will be completed in January.

Work on the Llorente–Tanglad Road was begun in October. This project comprises the repair of an old Spanish road which has been nearly impassable during the rainy seasons of the year.

During the early part of November, Mr. Aldrich, a prosperous farmer of northern Samar, installed an automobile service between Catarman and Carangian. The auto has been making from four to six trips per day between these two towns and the demand for this class of transportation is such that Mr. Aldrich will immediately install another automobile. This road at present is of the third class, the amount of traffic in northern Samar heretofore not justifying the construction of a first or even a second class road. If the demand for better transportation facilities continues to increase, as Mr. Aldrich's venture would indicate, it will no doubt become necessary to improve the condition of this road.

## SORSOGON PROVINCE.

In spite of the almost unprecedented rains of the past three months all roads under maintenance are in excellent condition, the only noticeable damage being that the binder has been washed out in a few places.

Orders have been placed for materials for the Sorsogon–Albay bridges. Work will start on these in the early part of the coming year.

Construction on the Sorsogon–Gubat Road has practically been at a standstill during the past quarter, except for quarrying stone. Hauling over the unsurfaced portion of the road was for most of the time absolutely impossible on account of the steady downpour of rain. A large quantity of rock is now on hand and the work will be very quickly completed after the weather improves.

On the Gubat–Bulusan section of the Sorsogon–South Road, several modern standard culverts have been completed and several old type culverts repaired and improved. The road has been graded sufficiently to admit of traffic, and considerable satisfaction is expressed by the local merchants and inhabitants.

Kilometer 2, Catbalogan-Maulong Road, Samar Province.

The Bulan–Irocin bridges consisting of an 18-meter reinforced-concrete arch, a two-span reinforced-concrete girder bridge of 10 meters each, and a one-span 10-meter reinforced-concrete girder have been completed. Within a couple of weeks traffic will be able to pass over them all, as now only a very little surfacing and backfill are lacking.

The materials for the Irocin school buildings have all been collected at Bulan. Transportation difficulties have cropped up, the local people wanting ₱8 for hauling 600 kilos over 21 kilometers of first-class road. Arrangements have, however, now been made with Señor Aramburo, who operates a 60 horsepower Mitchell touring car in Sorsogon, to put a small auto truck on the Bulan–Irocin Road and to carry the school materials for ₱5 per ton of 1,000 kilos.

Work has been resumed on the Colorado–Macatul Point Road in Aroroy, Masbate, and should be completed in February.

The gold mines in Aroroy are still booming, the Colorado being in full swing all the time, the Keystone is working steady, and the Syndicate will start work very shortly with a large plant. Crude petroleum engines are being used to advantage at the Keystone and Syndicate mines.

The town of Sorsogon of late greatly improved. It has now a small ice and refrigerating plant, a really decent theater building mostly used for cinematograph shows, and some of the merchants are getting busy putting in reinforced-concrete store buildings, notably Chino Jao Juntiao.

### SURIGAO.

Nothing received from the district engineer or division engineer.

### TAYABAS.

The Boac water system has been completed. Total cost ₱7,200. This system was constructed by administration and consists of two wells, each having a 170-foot depth of water connected up with a pumping plant by 6-inch galvanized-iron pipe. The pumping plant consists of one 60 horsepower boiler and one Worthington Duplex pump. The water is pumped to a reinforced-concrete standpipe with a capacity of 100,000 gallons. The pumping elevation is 125 feet. Every other street corner has a public hydrant. The unexpended balance will be expended on a public fountain in the plaza, which will have a concrete base 5 by 5 meters, a pedestal 4 meters high surmounted by a life sized figure of a Filipino child holding a fish. The statue is a donation by the Honorable Gregorio Nieva, private secretary to Speaker Osmeña.

Candelaria school, plan No. 10, Bureau of Education, is about 60 per cent completed.

Ground was broken for the Lucban market. This work will be an administration job. Main market, 18 by 10 meters.

Sariaya waterworks system construction has been inaugurated. The supply will come from a spring on Mount Banahao, 7 kilometers distance. The pipe line will be 2 kilometers 6-inch and 5 kilometers 2½-inch sizes. A reservoir capable of storing 100,000 gallons, with a settling tank, is planned. Good fire protection of 125 pound pressure is afforded through a natural slope of 8 per cent for 7 kilometers. One hundred houses will secure private installations. Estimated cost, ₱35,000. Work is being performed by administration.

The Lucena high school, plan No. 20, has progressed to where all the concrete footings are in place and one-half of the concrete floor girders completed. Rainy weather has delayed the work somewhat.

The buildings for the provincial exhibition and carnival, to be held in Lucena January 3 to 6, 1914, are completed.

Tayabas school construction is 95 per cent completed. The assembly hall is the largest in the province, being 40 by 54 meters. This is the old provincial building which was destroyed by fire and is now being entirely reconstructed.

The rain, together with lack of railroad facilities, have delayed work on the Candelaria–Tiaong section of the Manila–South Road. Lack of cars last month entailed a loss of ₱7,000.

Six bridges on the Atimonan–Gumaca section of the Manila–South Road will be advertised for bids on February 11, 1914.

Construction on the Mogpog school, plan No. 6, has been started by administration.

The province has 90 automobiles and trucks running over its first-class roads. Maintenance becomes more difficult as this class of traffic increases.

For the calendar year 1913 the province has had available for public works ₱645,000.

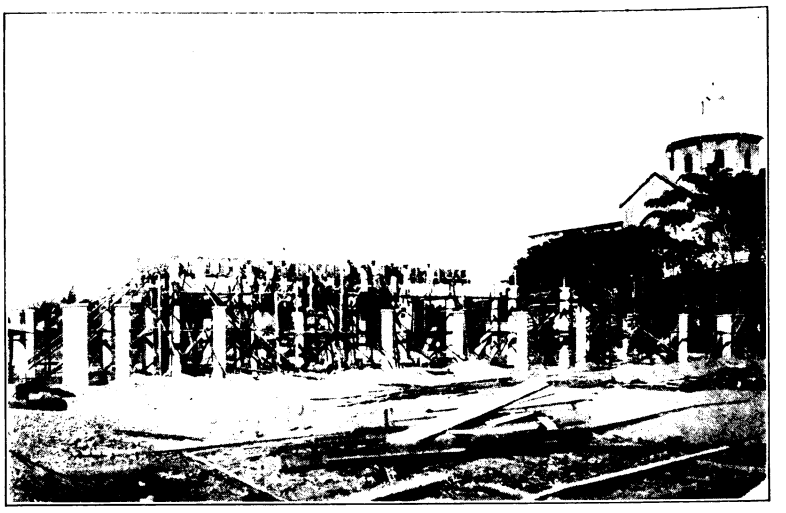
### TARLAC PROVINCE.

Bids were opened on December 1 for the construction of a type "B," 21 by 36 meter market in Victoria. Only one bid was received which was considered excessive. The work will be done by administration; estimated cost, ₱16,200.

Bids were opened on December 10 for the construction of a presidencia in Camiling. Only one bid was received for the work and it was practically 50 per cent in excess of the district engineer's estimate. The building will be constructed by administration with tile roof. The estimated cost is ₱32,700.

Bids were to be opened on December 15 for the construction of the Bilad bridge, Camiling, but none were received. The Insular Construction Company has kindly consented to rent sufficient equipment to the province for doing this work by administration. The bridge is of five 7-meter spans of reinforced concrete on concrete piles. Estimated cost, ₱15,000.

By January 1, 1914, the Tarlac–Gerona Road will be completed and the 5 kilometers (12 to 16) constructed since July 1 declared first class. The gravel for the road came from the Moriones River above Tarlac. This gravel was screened at the pit, hauled 4 kilometers by bamboo rafts, and delivered on the river bank near Tarlac at ₱2 per cubic meter for large gravel, and ₱2.30 for small gravel. Transportation on this river is rather difficult, it being necessary to use carabaos



Camiling market construction, Tarlac.

in getting the rafts upstream. At the river bank, the gravel was loaded into ¾-meter tramcars and hauled 9 kilometers to kilometer post 8 at a regular price or 12 centavos per car per kilometer, one carabao hauling two cars (1½ cubic meters.) Owing to lack of more rails the transportation for the remainder of the distance was done by bullcarts, each cart drawn by 2 carabaos hauling ¾ cubic meter. The price at the first was about ₱0.50 per cubic meter per kilometer, but was finally reduced to about ₱0.32. Considerable difficulty was had in holding together the newly constructed road which is surfaced 3 meters wide and 12½ centimeters deep under such heavy hauling. The gravel weighs about 4,300 pounds per cubic meter, and during the month of November about 600 cubic meters were transported. It would have been slightly cheaper to transport the gravel by railroad from Tarlac to Gerona for kilometer 15 and 16, but we were able to get only enough cars to transport gravel for a portion of kilometer 16.

The public works program for this province for the year of 1914 is as follows:

*Road and bridge work.*

| | |
|---|---|
| Maintenance: | |
| First-class roads | ₱22,100.00 |
| Second-class roads | 500.00 |
| Third-class roads | 4,000.00 |
| Reconstruction Sta. 3.400–3.600, Tarlac–Victoria Road | 2,100.00 |
| Construction: | |
| Santiago bridge (collapsible deck) | 3,000.00 |
| Bilad bridge | 15,000.00 |
| Capas–Concepción Road | 34,200.00 |
| Equipment (maintenance and purchase) | 2,000.00 |
| Investigation and surveys | 500.00 |
| Total road and bridges | 83,400.00 |

*Building work.*

| | |
|---|---|
| Completion Camiling market and tiendas | 15,000.00 |
| Construction: | |
| Victoria market | 16,200.00 |
| Tarlac market | 20,000.00 |
| Camiling presidencia | 32,700.00 |
| Matatalaib barrio school (3-room) | 6,500.00 |
| Sinilian 2.0 barrio school (2-room) | 3,300.00 |
| Total building work | 93,300.00 |
| Total road, bridges, and buildings | 177,100.00 |

### ZAMBALES.

Through the untiring efforts of the provincial board various Insular loans were secured on their last visit to Manila just before Christmas, as follows:

| | |
|---|---|
| For bridge and culvert constructions (provincial) | ₱60,000 |
| For the erection of a modern market in the town of Subic | 10,000 |
| For the erection of a modern market in the town of San Narciso | 10,000 |
| For the erection of a modern market in Iba, the provincial capital | 9,000 |
| Total | 89,000 |

The estimated road and bridge revenue of the province for the year 1914, including the regular Insular allotments, amounts to ₱40,000. With the Insular loan above mentioned added to this amount, Zambales will have next year ₱100,000 to replace with permanent structures all the wooden bridges and culverts on the Iba–Subic Road (with the exception of Balilis bridge between Iba and Botolan), as well as eight of the wooden bridges and large culverts on the Iba–North Boundary Road.

After an "expensive" delay lasting nearly seven months, the materials and pile driver for the construction of the four reinforced-concrete pile-bent bridges on the Iba–Subic Road, mentioned in the April, 1913,

issue of the Bulletin, were at last received, and actual construction is to begin right away.

The Iba–Beach and Iba–Botolan second-class road is being built first class by prison labor. There are from 60 to 70 men engaged daily in the building of subgrade. Over 60 of these prisoners belonged to the young "Katipuneros" who were given from six months to one year "free board and quarters" within the walls of Iba jail for "hiking" to the hills of Castillejos and San Marcelino last August.

Three "American ingot-iron culverts" of 24-inch diameter by 16 feet long have recently been constructed between San Antonio and San Marcelino on the Iba–Subic Road. For the sake of comparison of cost with the Bureau standard reinforced-concrete pipe culverts, the same head walls as provided for the latter were used. The following is a comparison of cost, including surcharges:

| | Single line. | | Double line. | |
|---|---|---|---|---|
| | Roadway. | Cost. | Roadway. | Cost. |
| | *Meters.* | | *Meters.* | |
| American ingot-iron culvert, 24-inch diameter | 4.40 | ₱156.00 | 4.40 | ₱266.00 |
| Standard reinforced-concrete pipe culvert, 24-inch diameter | 5.50 | 110.00 | 5.50 | 160.00 |
| Difference in favor of concrete | | 46.00 | | 106.00 |

Below is the itemized cost of the American ingot-iron culvert:

| | Single line. | Double line. |
|---|---|---|
| Cement at ₱6.153 per barrel, including transportation from Manila (2½ barrels for single and 3 barrels for double line) | ₱15.38 | ₱18.45 |
| Reinforcing steel, ½ inch | 5.00 | 6.53 |
| Pipes at ₱9.93 per length (8 lengths for single and 16 lengths for double) | 79.44 | 158.88 |
| Discharging the above and transportation to site | 3.13 | 4.33 |
| Gravel, including metaling on top (1.125 cubic meters for single and 1.875 cubic meters for double) at ₱3.33½ | 3.75 | 6.25 |
| Labor including gathering of sand for concrete | 29.67 | 38.46 |
| Miscellaneous | .78 | .77 |
| Surcharges, Insular and provincial, 14 per cent | 19.20 | 32.72 |
| Total cost | 156.35 | 266.40 |

From the above result it appears that where concrete pipes can be advantageously made, concrete pipe culvert will be found cheaper than American ingot-iron culvert of the same size. In places, however, where means of transportation is difficult and where good sand and gravel for concrete work are scarce, the American ingot-iron culvert without concrete head walls (riprapping with stones about the ends of the pipes will be sufficient) may come in very handy. On roads or trails of uncertain locations this type of pipe culvert will be found specially adaptable, as the pipes can be easily removed, transported, and replaced where desired when the final location is definitely decided upon. The writer, nevertheless, questions its durability (not the strength) compared with reinforced-concrete pipe, and on this account the date of construction of each of the aforesaid three culverts were marked on the parapet walls for future reference and observation.

The San Narciso schoolhouse, plan No. 10, completed since last August and mentioned in the July issue, 1913, of the Bulletin, was formally inaugurated on the 28th of November last. It being school holidays from the 27th to the end of the month, all the students of the Iba high school, over 200 strong, the pupils from Yangco school, San Felipe, and Olongapo, and a big crowd of citizens from all over the province and some provincial officials, all came down to San Narciso to witness the grand dedication of the school. It was the regret, however, of everyone present that the well-known Filipino philanthropist who donated ₱5,000 to the school, Don Teodoro R. Yangco, was not able to come, but it was gratifying to hear his name highly eulogized in all the speeches delivered on the occasion. It was here that the writer learned that district engineers building schoolhouses should take lessons in oratory before the building is finished. The most notable events were the various athletic meets, in which the students showed no less school spirit in rooting and singing for their teams than in the States, and the elder folks forgot their customary visits to the cockpits.

The building was completed inside of four calendar months at a total cost of ₱18,602.88, including all surcharges, by administration, under a native foreman, the estimated cost being ₱21,000 and the appropriation ₱20,000. The lowest contract bid was that of Mariano Velasco & Co. at ₱22,999 and two hundred and twenty working days, which was exclusive of surcharges and other incidentals. The essential thing on schoolhouse construction to obtain the best results is not to begin the work until all the necessary appropriation is made available and all the required materials ready at the site of work.

## GENERAL ITEMS.

*Insular funds for roads and bridges, fiscal year beginning July 1, 1908, to October 15, 1913.*

| Province. | Total amount. | Per capita. |
|---|---|---|
| Albay | ₱471,692.25 | ₱1.96 |
| Ambos Camarines | 266,808.50 | 1.11 |
| Antique | 108,006.95 | .80 |
| Bataan | 62,522.35 | 1.33 |
| Batanes | 4,895.95 | |
| Batangas | 371,304.75 | 1.44 |
| Bohol | 328,331.25 | 1.22 |
| Bulacan | 432,525.25 | 1.93 |
| Cagayan | 133,714.55 | .85 |
| Capiz | 348,410.70 | 1.23 |
| Cavite | 250,414.55 | 1.86 |
| Cebu | 894,466.50 | 1.37 |
| Ilocos Norte | 246,012.95 | 1.37 |
| Ilocos Sur | 424,295.10 | 1.84 |
| Iloilo | 567,125.40 | 1.38 |
| Isabela | 87,575.35 | 1.15 |
| La Laguna | 531,537.55 | 3.58 |
| La Union | 245,604.40 | 1.99 |
| Leyte | 411,379.00 | 1.05 |
| Mindoro | 32,759.10 | |
| Misamis | 155,390.60 | 1.17 |
| Nueva Ecija | 228,606.95 | 1.70 |
| Occidental Negros | 297,774.00 | .97 |
| Oriental Negros | 227,169.10 | 1.13 |
| Palawan | 28,495.85 | |
| Pampanga | 217,322.10 | .97 |
| Pangasinan | 548,484.10 | 1.24 |
| Rizal | 630,071.70 | 4.17 |
| Samar | 259,298.55 | .97 |
| Sorsogon | 201,847.15 | 1.23 |
| Surigao | 76,305.00 | .95 |
| Tarlac | 115,150.90 | .85 |
| Tayabas | 227,302.80 | 1.11 |
| Zambales | 113,773.80 | 1.90 |
| Grand total | 9,546,375.00 | |

### SCIENTIFIC STRUCTURAL DESIGN.

The proper engineering design of a modern business building is of equal importance with the architectural design. To make a building strong enough without wasting material, to know what kind of material to use for any given stress, and to mold all into the structure in harmony with the architectural design, requires engineering ability of the highest order.

Mere mass is of no avail in structural design, the material must be so placed as to develop its ability to resist strain. When enough material has been properly placed to care for a given stress, any additional material becomes a handicap and an additional load without adding to the value of the structure.

Many great buildings exist to-day that are dangerously near to collapse because the material in them has not been properly distributed. Some beams are too heavy, some are too light, the walls may be strong enough, and the foundations not ample. In many expensive buildings, cracks and settlements develop because the material in the building is not properly distributed, even though there may be enough material in total.

Many architects turn the structural design of their buildings over to firms handling some special system of structural design, agreeing to specify the one that can be built for the least money. The temptation to take chances is too great for some of them to resist and designs are submitted that are cheap in price but dangerous. Every few months one of these buildings fails with loss of life and property. The designers claim that the workmanship was faulty, the builder claims that the design is insufficient. Neither can be proven responsible and the owner must assume the loss.

It requires engineers of large experience to know not only how to get the most out of their material, but also to use only material that is standard and can be obtained at the minimum price and without delay. Cost of labor is the great item in modern building construction and the experienced engineers design their material so that it can be handled with the least labor.

The engineer, the architect, and the business man are all needed in the modern building organization, and the engineer is of equal importance with the other two. (Steven's Monthly.)

PLANNING MUNICIPAL BUILDING CONSTRUCTION.

During 1913 five market buildings have been built and put into operation in the Province of Bulacan. The work of securing funds for these markets was entirely in the hands of the provincial treasurer and it is due to his activity that the market buildings have been constructed.

The claim made for the new markets is that they not only provide a more sanitary place in which to buy and sell, but that they also increase the revenues of the towns in which they are built. The provincial treasurer has furnished the following tabulation showing the market collections of the five towns where new markets have been constructed for the year 1912, as actually collected, and for the year 1913 based on the average for the months since the new market has been completed. This information is tabulated below:

| | Insular loan. | Receipts of old market, 1912. | Receipts of new market, 1913. | Increase. |
|---|---|---|---|---|
| Hagonoy | ₱25,000.00 | ₱1,971.00 | ₱4,272.00 | ₱2,301.00 |
| Santa Maria | 10,000.00 | 679.00 | 1,380.00 | 701.00 |
| Paombong | 6,000.00 | 312.00 | 684.00 | 372.00 |
| Meycauayan | 20,000.00 | 1,961.00 | 3,636.00 | 1,675.00 |
| Obando | 7,500.00 | 350.00 | 720.00 | 370.00 |

From this table it is seen that the collections in every case have approximately doubled with the construction of a modern market and that this increase is sufficient, in most cases, to pay more than half of the annual charges for reimbursement of the original loan and its interest. Moreover the collections are steadily increasing and the financial advantage of the modern market will be more emphasized as these markets become better established.

One matter that should not be overlooked in towns which are contemplating the construction of new buildings is the question of revenue. Very often a town finds itself in need of more school buildings, a new presidencia, and also a new market. The above table shows very clearly the reason why the market building should be the first of the three constructed. If the presidencia is constructed or if the school buildings are constructed it will usually be necessary to borrow funds for this purpose and until the loan is repaid the municipal treasury must meet the obligation out of current revenues. The construction of a presidencia or school building by borrowing funds to be repaid from the municipal general funds may, therefore, easily prevent any further building during the entire life of the loan.

Failure to construct the necessary market buildings first may easily so embarrass the municipality's finances as to seriously hinder the proper progress of its normal building program. For this reason this feature of the building situation in all municipalities should be carefully gone over before venturing the construction of any new buildings.

THIRD ANNUAL ROAD CONGRESS AT DETRIOT, MICHIGAN, SEPTEMBER 29 TO OCTOBER 4, 1913.

At the American Road Congress many interesting papers were presented covering highway work administration, construction, and maintenance for all classes of highways in the United States and other countries.

The attendance at this congress numbered 3,600 men interested in highway work. Special interest was shown in the Wayne County concrete roads adjacent to Detroit, this system being the best known for this particular pavement in the United States.

The European conditions as contrasted to the present situation in the United States on highway construction was ably reviewed by Col. William D. Sohier, chairman, Massachusetts Highway Commission, whose conclusion is given herewith:

CONCLUSION.

In conclusion, I would not discourage any "good-road" movement in this country, but we must go at it in a proper and scientific manner and know what our problem is before we tackle it, then proced in a businesslike manner to build our roads.

We must realize the enormous amounts of money involved, and we must also realize the tremendous amount of money that is required to keep the roads in good condition after they are built.

In my opinion we have engineers who can do as good in this country as anyone has done abroad.

We may even learn to build them better, but we must realize that it requires education, skill, intelligence, and experience, and that constant maintenance is absolutely essential.

Maintenance begins the day the road is built and continues as long as it is used, and the money for maintenance must be provided as well as the money for construction, or we shall find that the bonds issued to construct our roads still remain to be paid when the roads have long passed away.

The money cannot be provided nor the roads built at once. If we are to secure good roads we must all join hands—the town, the city, the country, the State, and possibly the nation also; but it must be upon a carefully prepared plan made by competent engineers after a full study of the whole problem. Only by coöperation can our country secure any comprehensive highway development within the next twenty-five years.

The question of Federal aid in road construction was presented by Mr. David F. Houston, Secretary of Agriculture, in a very able manner.

In substance his attitude is expressed in an abstract of his paper given herewith:

In short, as a practical program, I believe that this matter is one in which haste can best be slowly made. The people will sanction a reasonable expenditure of their money—and it is their money, and theirs only, whether it be expended through the Federal Government or the State—when they are convinced that it is applied to a wise purpose and will yield the results anticipated. And I am impressed by the wisdom of the action of Congress, in the midst of so much clamor, in constituting a committee "to make inquiry into the subject of Federal aid in the construction of post roads," in providing an appropriation of $500,000 to be expended coöperatively with the State in the proportion of 1 to 2, and in requiring the Secretary of Agriculture and the Postmaster-General to report to Congress the results of such expenditure, "together with such recommendation as shall seem wise for providing a general plan of national aid for the improvement of postal roads in coöperation with the States and counties, and to bring about as nearly as possible such coöperation among the various States as will insure uniform and equitable interstate highway regulations." This indicates a wholesome desire to know the facts as well as a generous interest. Too short a time has elapsed to judge of the value of this undertaking; but that it is in the right direction, few will question. That it might be extended with ample funds if aid is to be furnished, most thoughtful men would concede; and the plan has the peculiar value of being susceptible of indefinite extension in case the results should be found to justify it.

The impression left in the minds of readers of the reports of both the road congresses for 1913 is that although highway engineering has, during the last decade, evolved from the stage where any old town supervisor could build a road to the stage where high technical skill is now required, there still remain problems to solve in highway work that will require years of study of the modern constructions now in place or in progress and the use of a still higher grade of technical executive to direct future highway legislation, construction, and maintenance.

THIRD INTERNATIONAL ROAD CONGRESS HELD AT LONDON, ENGLAND, 1913.

The Third International Road Congress held its session in London, England, during the week ending June 28, 1913. At this congress the representatives of 39 countries met to discuss nine vital highway subjects that were presented to the congress in 67 papers prepared by able men known to be specialists in the special highway subjects with which they dealt.

Although it was recognized that some of the data upon which some of the final conclusions were based lacked a definition that could only be secured by a longer period of observation, nevertheless this congress before adjourning adopted resolutions which show a decided advance in the knowledge of highway requirements for planning, construction, and maintenance.

These resolutions are given herewith:

PLANNING OF NEW STREETS AND ROADS.

1. As a general principle, it is better that new main roads be constructed to pass outside rather than through towns, and that, where an existing main road passing through a town is unsatisfactory for through traffic, it is often better, in preference to widening an existing narrow main road through the center of a town, that new roads should be planned according to the principles of the science of town planning.

2. Gradients on new roads should be as easy as possible, having regard to the physical character of the country through which they pass, and they should be easier where there are curves, trams, or a preponderance of heavy traffic.

3. The radii of curves in roads used by fast traffic should, where practicable, provide the best possible and an unobstructed view, and that where this is not possible, the curve being of too short a radius, means should be provided whereby the approach thereto is in some way clearly indicated.

4. Except where it is possible to provide special reserved spaces, tram tracks are best placed in the center of the roads, and that where so placed it is desirable to provide space on either side for two tracks for vehicles.

5. The main traffic roads should be so designed that spaces are provided for tram tracks, fast and slow traffic, and standing vehicles; and in such a way that they can proceed without unduly intermixing. In fixing building lines along what may ultimately become main roads, regard should be paid to ultimate requirements. Adequate space should be provided between the buildings, and powers for enforcing this should be held by all authorities who decide the widths of roads.

6. That the planning of main road communication between outside towns should be at once undertaken; it is a matter of national importance in regard to which some initiative should rest with a central State authority, and the action of local authorities should to some extent be regulated or supervised by central State authorities.

TYPES OF SURFACING TO BE ADOPTED ON BRIDGES, VIADUCTS, ETC.

1. The choice of road surfacing for bridges depends on the nature and intensity of the traffic, the local conditions, such as permissible first cost, kinds of material readily available, and climate. For light bridges the choice is largely influenced by the weight of the surfacing. Public safety and convenience should be first regarded rather than questions of comparative cost.

2. On short bridges in town or country it is desirable that the surface should be the same as the adjoining streets or roads.

3. In forming the roadway on bridges, special care should be taken to secure proper drainage and to prevent the harmful percolation of water. With longitudinal gradients of at least 1 in 50, the cross section of the surface may be made nearly flat and the dead load thus reduced.

4. As a general rule, the surfacing of a bridge should be waterproof, capable of resistance to wear, durable, and of a weight appropriate to the structure of the bridge; it should also be as smooth as possible without being slippery.

5. Plank surfacing on bridges is light and its first cost is low. Its cost of maintenance is, however, excessive, except where the traffic is light. Its extreme liability to damage by fire is a serious disadvantage. It should not be adopted, except in remote districts in which there is an abundance of cheap timber, and where a more desirable form of surfacing is not easily obtainable. Single plank floors are only suitable for very light traffic. For moderate or heavy traffic, two layers of planking, the lower of which is creosoted or otherwise protected from rapid decay, should be used.

6. Macadam, or ordinary broken-stone surfacing, on timber planking is not always satisfactory on account of its great weight and its permeability. Macadam is, however, quite satisfactory for massive bridges in rural districts, if the substructure has a proper damp course.

7. Macadam, bound with tar or other waterproof and elastic material, is useful and economical for the surfacing of rural bridges with moderate traffic, when the spans are short or the structure is massive.

8. Wood-block paving, 3 to 5 inches thick, is an ideal surfacing for bridges in most cases. It is light and durable and can be laid on concrete, or, when weight must be minimized, on a timber subfloor, which should be creosoted. Special care should be taken in the selection, treatment, and laying of wood blocks for bridge paving to avoid troubles due to expansion and contraction of the blocks or of the metal structure.

9. Asphalt in various forms is an excellent surfacing material for bridges with easy gradients on which the traffic is not confined to definite lines or very heavy.

10. Stone paving, carried out either with ordinary hand-dressed setts or with small setts (Durax; Kleinpflaster), laid on concrete and bound with cement or pitch, makes excellent and economical surfacings for bridges with heavy traffic. However, it is only suitable in cases where questions of the weight of the surfacing or of noise are of no importance. The thickness of the layer of sand interposed between the setts and the foundation will be decided in the same way as with an ordinary carriageway in town or country, as the case may be.

11. For movable bridges and for nonrigid suspension bridges, the surfacing should be light and easy to attach to the bridge platform. The trials made in France and Belgium with old mine cables, or other fibrous substances of even less cost, and with such materials impregnated with tarry, bituminous, or asphaltic materials, should be encouraged.

CONSTRUCTION OF MACADAMIZED ROADS BOUND WITH TARRY, BITUMINOUS, OR ASPHALTIC MATERIALS.

*General conclusions.*—By the use of bituminous, including tarry or asphaltic, binders we may obtain a number of different forms of road crust, which may be employed with advantage, according to the various conditions of the road as regards traffic, locality, and climate.

The exact value and duration of life of these various road crusts, taking into account traffic, climatic conditions, and the methods of construction remain to be determined.

For this purpose it is advisable to draw up a uniform system of tests, measurements, and records under the following headings: (1) Physical and local conditions (plans, cross section, slopes, camber foundations, subsoil.) (2) Materials employed, petrological analysis, dimensions, composition of the binding agent. (2*a*) Method of construction, date of construction. (3) Census of traffic on the section under review. (4) Climatic conditions affecting the road. (5) Periodical measurement of wear. (6) Periodical examination of the state of the road crust. (7) Actual cost of the road crust: (*a*) as regards cost of construction; (*b*) as regards maintenance cost.

The standard form in which the information is to be furnished will be drawn up by the permanent commission.

*Particular conclusions—Foundation and drainage.*—Confirming the conclusions adopted in 1910 by the second congress (Brussels, question 2, which called attention to the advantages of a dry foundation and a sound subsoil, the congress especially insists upon the great importance of efficient foundations in the case of road crusts bound with bituminous (including tarry or asphaltic) binders for the following reasons: (1) The road crust being expensive, it is important to give it a base which will increase its life. (2) As the weight, speed, and intensity of the traffic continually tend to increase on roads considered worthy of such a crust, it is best to provide a foundation which has been so constructed as to secure for the crust the best possible conditions of resistance to wear.

DIMENSIONS AND SHAPE OF METALING.

1. When an ordinary macadamized road crust is constructed with a view to being tar sprayed, it should be constructed of hard metal, with sharp edges, and broken as nearly as possible to a cube of the dimensions of from 4 to 6 centimeters.

2. In the case of bituminous, including tarry or asphaltic macadam, carried out by the mixing process, the dimensions of the metal may be so selected and graded as to form a compact road crust with the fewest possible voids. The dimensions of the largest metal may vary according to the nature of the stone and of the traffic. When the process of construction employed requires more than one layer of material, the upper layer or wearing crust may be formed of smaller metal.

3. In respect of bituminous, including tarry or asphaltic road crusts constructed by the penetration process, the trials and tests now being carried out in various countries should be continued, taking care only to employ metal of as cubical a shape as possible, and with sharp edges, at any rate, for the portion of the road crust nearest the surface.

4. It is understood that further experiments will also be carried out in the use of other methods and especially those referred to in 1 and 2.

EMPLOYMENT OF PARTIALLY USED METAL.

By carefully eliminating all particles of mud and organic matter it is possible to successfully make use of partially worn materials on condition that they are not employed for the surface of the road crust.

RELATIVE IMPORTANCE OF PATCHING.

It is agreed that it is absolutely necessary to carry out repairs, in the case of all bituminous, including tarry and asphaltic road crusts, immediately the necessity for them arises.

PERMISSIBLE WEAR.

The complete renewal rendered necessary by wear must be carried out immediately the depth of the road crust is below a given limit of safety, or when its waterproofing qualities have become so poor that the road will unduly suffer from climate conditions.

VARIOUS MEANS OF EMPLOYING TARRY, BITUMINOUS, AND ASPHALTIC MATERIALS.

In using these materials both in the penetration method and the mixing method: (*a*) It is preferable to use dry stone in order that it may adhere well to the binder. In the mixing method the stone must always be dry, and, if necessary, it must be heated. (*b*) One must never lay a top crust upon a soft or damp foundation. One should preferably carry out the work in fine weather. (*c*) One must never employ too much binder, but only a sufficient quantity to bind the portion of the road which is being rolled. (*d*) One must never employ road rollers which are too heavy.

TEST AND CHEMICAL ANALYSIS.

The advantages of analyses and methodical laboratory tests, and their necessity in the case of bituminous binders, are unanimously recognized. It would be of advantage to obtain uniformity (1) as regards the specification of the principal characteristics of these binders, (2) as regards the methods of testing for drawing up these specifications. The Permanent International Commission will be entrusted with the work of inquiring into the best way of standardizing the above.

CLIMATIC EFFECTS.

It appears to be generally agreed that certain tarry, bituminous, or asphaltic road crusts (as is also usually the case with all smooth and waterproof road surfaces) may become slippery under certain conditions of weather. This may be remedied by strewing the surface with coarse, sharp sand; and in most cases a good cleansing of the surface will usually prevent the carriageway becoming slippery.

EFFECTS ON PUBLIC HEALTH.

Sufficient information is now available to enable engineers to select and specify bituminous binders which will have no prejudicial effect upon public health, fish life, or vegetation; but which, on the contrary, will conduce to conditions of considerable hygienic advantage.

CLEANSING AND WATERING.

It is recognized that carriageways properly treated with bituminous, including tarry or asphaltic materials, require less sweeping and watering than ordinary water-bound macadamized roads, and that they allow of considerable economy being effected under this head.

The meeting puts forward the following additional proposal: That an international technical committee should be appointed by the Permanent International Commission in order to study a standard method of obtaining information and data upon materials, physical conditions, local conditions, methods of construction, terminology, and other points concerning macadam bound with tarry bituminous or asphaltic binders.

The report of the committee should, after examination by the Permanent Commission, be presented to a next Congress.

WOOD PAVING.

1. Where gradients permit, wood-block pavement is very suitable for streets where the traffic is great, but is not of the exceptionally heavy character usually existing on streets near docks or similar centers of industrial traffic. It should be used where a noiseless pavement is desirable. It is of great importance that a concrete foundation should be laid of sufficient strength to carry the traffic passing over the pavement.

2. Great care is necessary in the selection of the proper timber for the purpose, and all softwood blocks should be thoroughly impregnated with a well-proved preservative before being laid.

3. In view of the varying results given by wood pavements, according to local circumstances, it is desirable that further investigations and laboratory experiments should be carried out in connection with the selection of the timber and of the impregnating preservative.

4. Every precaution should be taken in laying the blocks to prevent, so far as possible, the entry of water through the joints.

4*a*. Hard woods give varying results according to local circumstances, and it does not appear desirable to recommend them for roads with intense traffic in large cities, unless some means are devised to effectively prevent the rapid destruction of the joints and the resulting destructive effect on the concrete below. If these woods are employed it is desirable not only to prevent the percolation of water through the joints to the foundation, but also to consolidate the blocks as far as possible, so that they may not become rounded at the edges.

Soft wood obtained from suitable kinds of trees, and especially from resinous species, are equally suitable for roads with a comparatively heavy and intense traffic as well as for roads with a light and infrequent trafic. In the latter, however, the blocks are liable to rot if they have not been suitably pickled. It is also desirable to make the joints as small and watertight as possible. On the other hand, their comparatively rapid wear on roads with great traffic should encourage one to make exhaustive investigations into the best means of treating them, so as to increase their strength without prejudice to their elasticity.

5. Subject to certain precautions, such as impregnating of the wood, waterproofing of the joints and surface, frequent cleaning of the roadway, etc., there is no objection to wood pavement from the sanitary point of view.

6. The spreading of gritting is necessary under certain conditions and in certain weather (especially on hardwood paving) to prevent the surface becoming slippery, but the gritting should be done with suitable small gravel chippings or sharp sand so as to avoid as far posible any injury to rubber tires.

METHODS OF LIGHTING.

For the purposes of general determination of methods of lighting, highways may conveniently be divided into three classes as follows: (1) Important streets in cities, towns, and other urban areas in which the traffic after dark is considerable in volume; (2) important suburban roads in the vicinity of large towns; (3) rural roads in open country. Having regard to modern conditions of traffic it is essential that adequate lighting by means of fixed lights should be provided in classes 1 and 2.

As a general principle in the lighting of all highways which require to be lighted by means of fixed lights, the method of lighting to be adopted should be such as will provide illumination as uniform and free from glare as possible. The amount of illumination and the position of lamps must be determined with reference to local circumstances.

It would be impracticable to light rural roads in open country generally by similar methods to those adopted in urban streets or suburban roads, and the lighting of vehicles running or standing on rural roads at night is therefore of the highest importance.

Every vehicle, whether standing or moving, should carry or show a light of sufficient power at night which can, except when specially authorized, be seen from the rear as well as from the front of the vehicle.

Every moter car must carry after nightfall two lighted lamps in front and one at the back; if it is able to move at a high speed it must be fitted in front with a headlight of sufficient illuminating power to light up the road or path for at least 50 yards to the front. In inhabited places where the ordinary lighting is sufficient to allow motorists to see their way and to be easily seen, the light of the headlights must be limited to that of the ordinary lamps.

It is desirable that all obstacles across a road such as gates, and particularly gates at railway level crossings. should be painted white and in other colors in alternate parts, and illuminated by fixed lights which are lighted at dark.

It is desirable to paint white or indicate by some other methed all danger signal posts, direction and other posts milestones, wheel curbs bridge abutments, etc., or other special features, the indication of which would aid travelers or conduce to the safety and convenience of the traffic.

One and the same color should be universally adopted as the color for danger signals.

The meeting on the proposal of Mr. Chaix, unanimously adopted the following resolution: "It is desirable that each government should do away as soon as possible with colored lights on automobiles."

On the proposal of Mr. Hansez, the meeting adopted the following regulation, with two dissentients: "The congress expresses the wish that regulations should be made to compel drivers of herds of cattle to make their presence known at night."

OBSERVATIONS NOTED SINCE 1908 AS TO VARIOUS CAUSES OF WEAR AND OF DETERIORATION OF ROADWAYS.

1. Weather conditions are among the most powerful influences which cause deterioration of roads, and that the destructive effect of weather can be minimized by effective waterproofing of the road surface, with suitable drainage for the foundation.

2. Any considerable volume of traffic consisting of either heavy motor vehicles or high-speed light motor cars has a seriously damaging effect on waterbound macadam roads. The damage caused is effected by the balancing of the motor; the ratio between propelling power and adhesive weight of unsprung portions of the motor; the progressivity of action of the brakes; the system of springing; the type of tires employed; the diameter of the wheels; the width of the rims; variation of speed and adherence; and other factors.

3. The damaging effect of heavy motor vehicles can be minimized by the use of wheels of large diameter: tires of a width properly adapted to the weight of the axle load; rubber or elastic tires and suitable springs and that all reasonable means of reducing the damage to roads caused by such vehicles should be enforced.

4. Light motor traffic does not cause serious or exceptional wear or damage in the case of properly made macadam roads which have been properly treated or bound with tarry, bituminous, or asphaltic materials, except in sharp curves.

As regards horse-drawn vehicles it is desirable also to study the relations between load, with or rims and diameter of wheels, and more especially the system of shoeing horses. It is also necessary that the power should be given to local authorities to prevent the deposit of refuse from the fields and earth upon the roadway by the wheels of agricultural carts.

5. There is still a great lack of precise information in regard to the various causes of wear and deterioration of roadways and that it is desirable to collect more information compiled on carefully devised scientific methods standardized as far as possible for the purposes of comparison, and to make further systematic study of these causes.

The International Permanent Commission is charged with the preparation of a program of observations, studies, and experiments.

REGULATION FOR FAST AND SLOW TRAFFIC ON ROADS.

1. That all regulations for the control of road traffic should be based on the principle of allowing the speed practicable for each different kind of vehicle consistent with public safety, general convenience, and normal wear of the road.

2. That regulations for the conduct of fast and slow traffic should

be as few and simple as possible and should be such as can be universally adhered to and enforced.

3. That in all large cities there should be a traffic authority on whom should be charged the duty of studying and dealing with street traffic problems, the powers of such authority and the coördination of such powers with those of other public authorities being matters of detail which must be settled by public authorities on considerations of the circumstances and conditions of each large city.

4. That there should be ample provision of traffic controllers (such as the police in London) with adequate powers to regulate the traffic, not only at congested points, but throughout the course of crowded streets.

5. That having regard to the increased danger which is necessarily created by the conditions of modern traffic it is important that drivers should be carefully and systematically trained, and that children should be specially taught how to provide against the danger of the road.

6. That except where local circumstances render it absolutely necessary, no obstructions, such as lamp-posts, tramway standards, etc., should be placed in the center of a road, except necessary refuges for pedestrians crossing.

7. No obstruction of the public highway should be permitted either by vehicles standing unreasonably, or traveling at an obstructing speed, or by things placed on the highway. Exception must, however, be made for depots required for the work of maintenance or repair of the road, or for work being carried out by duly authorized and competent authorities, but in every case, all necessary steps must be taken to ensure the safety of traffic.

The meeting, on the proposal of Mr. Chaix, unanimously adopted the following resolution:

8. "Regulations for roads and traffic must aim at defining the rights, duties, and responsibilities for each kind of traffic, in order to avoid the causes of accidents and damage and to ensure the maximum of order and liberty."

AUTHORITIES IN CHARGE OF THE CONSTRUCTION AND MAINTENANCE OF ROADS.

1. The system of road administration in any country must be in harmony with the general system of government prevailing in that country and the political genius of its people. It is impossible, therefore, to lay down any general rule of universal application as to the extent to which the road organization of any country should be centralized or decentralized.

2. A principle that can be laid down as of universal application is, that the unit of highway administration shall be sufficiently large and command sufficient resources to employ and adequately remunerate a competent staff.

FINANCE OF THE CONSTRUCTION AND UPKEEP OF ROADS.

1. The expenditure on the maintenance and improvement of (*a*) the roads which serve as main routes of communication between important places in any country, or (*b*) roads which are used mainly by long distance traffic, unless such expenditure is borne wholly out of the national revenues under a system of state administration of roads (which system is practicable and suitable in the case of some roads in some countries) should be mainly paid for out of national revenues, whether or not such roads are locally administered, and maintained, subject, where local administration prevails, to the supervision of a central government authority both as to efficiency and expenditure.

2. It is desirable to abolish, so far as possible, all tolls on public roads, but it is equitable that vehicles which, on account of their weight or weight combined with speed or any other exceptional circumstances connected with either the vehicle or use of the road, cause special damage to roads bevond the wear and tear of the ordinary traffic of any district, should be subject to special taxation the proceeds of which should be earmarked for expenditure on roads.

3. Borrowing money for new road construction and for the periodic renewal of the surface coating of a road is consistent with sound financial principles provided that the loan period in the case of loans for renewals, is kept well within the life of the surface coating.

These resolutions, though embodying many facts that have been recognized and accepted for some years in the Philippine highway work, contain many suggestions that might be included in the Philippine laws with considerable improvement such as the power, color, and use of lights on automobiles and other vehicles, also the methods of painting certain highway structures and to make clear the danger spots.

After studying these resolutions it seems a matter of regret that the Philippine Government was not represented at this congress.

Success has been attained in the Philippines in financing highway constructions of all classes, in forming a maintenance organization that for effective work cannot be surpassed: and in the design, location and construction of permanent highway bridges. These are all vital questions upon which the highway world is looking for more light and, though conditions as to government, climate, location, labor, and materials may differ from other countries, it is believed that, as a duty to the world at large, the success that has obtained in the Philippines in solving these problems should be presented, clear and concise, at future highway congresses, that these laws, systems, or policies may be adapted studied, discussed, and bettered to meet conditions other than prevail here.

BITUMINOUS MACADAM.

The papers contributed by Americans were mentioned with appreciation by the reporters, and from the address on planning new streets and roads liberal excerpts were made.

The sessions of the section which attracted the largest number of persons were those involving construction and maintenance. The discussion of the question of the construction of macadamized roads bound with tarry, bituminous, or asphaltic materials was largely attended and was quite prolonged. It involved the question of terminology. Quite aside from the congress itself this has been taken up by the Engineering Standards Committee of Great Britain, which has invited the coöperation of the several American societies who are interested in the subject in order to arrive at some agreement between the English-speaking races before attempting to put the matter before other nations.

## FINANCIAL.

*Appropriations and allotments for the Insular fiscal year, beginning July 1, 1913.*

In addition to the regular and special allotments reported in the issue of the Bulletin dated October 1, 1913, the following regular allotments have been released and alloted from ₱250,000 appropriated by Act No. 2264, section 2, paragraph (*f*), these regular allotments distributed on the population basis:

| | | | |
|---|---|---|---|
| Albay | ₱8,898.75 | Laguna | ₱5,219.25 |
| Ambos Camarines | 8,872.50 | Pangasinan | 16,388.50 |
| Cavite | 4,984.25 | Rizal | 5,584.50 |
| Ilocos Sur | 8,533.50 | Tayabas | 7,568.00 |

In addition from the funds appropriated by Act No. 1988, the following special allotments have been made to the provinces and in the amount as set out under the funds available on or before January 1, 1914:

| | |
|---|---|
| Batangas Province, for the construction and reconstruction of first-class roads | ₱25,000 |
| Pangasinan Province, for the construction and reconstruction of the Santa Barbara–Calasiao Road, bridges, and culverts | 10,000 |
| Tayabas Province, for the construction and reconstruction of the Sariaya-Tiaong Road, bridges, and culverts | 30,000 |

*Loans for roads, bridges, schools, municipal and provincial buildings, etc., from September 28, 1913, to December 24, 1913.*

| Provinces and projects. | Acts Nos.— 1323. | 1728. | 1729. | 2083. | Total. |
|---|---|---|---|---|---|
| Albay: For the purpose of continuing the construction of trails, subprovince of Catanduanes | | ₱15,000 | | | ₱15,000 |
| Ambos Camarines: Balos bridge | ₱7,500 | | | | 7,500 |
| Batangas: | | | | | |
| Municipal building, Lemery | | 6,000 | ₱3,000 | | 9,000 |
| Taal market | | 6,000 | 9,000 | | 15,000 |
| Bohol: Loboc market | 6,250 | | | | 6,250 |
| City of Baguio: Electric-lighting plant | | | | ₱60,000 | 60,000 |
| Capiz: Provincial building | | 16,500 | 38,500 | | 55,000 |
| Ilocos Norte: Batac market | 11,000 | 4,400 | 6,600 | | 22,000 |
| Iloilo: School building, Iloilo | | | 12,500 | | 12,500 |
| La Union: Naguilian market | 8,000 | | | | 8,000 |
| Leyte: | | | | | |
| Baybay market | 10,000 | | | | 10,000 |
| Tacloban market | | | 12,500 | | 12,500 |
| Occidental Negros: San Carlos market | | | 9,000 | | 9,000 |
| Oriental Negros: | | | | | |
| Bais market | | 2,400 | 3,600 | | 6,000 |
| Dumaguete market | | 4,400 | 6,600 | | 11,000 |
| Pampanga: Mabalacat artesian well | | | 1,000 | | 1,000 |
| Pangasinan: Municipal building, Urdaneta | | 5,000 | 5,000 | | 10,000 |
| Tarlac: | | | | | |
| Victoria market | 9,000 | 3,600 | 5,400 | | 18,000 |
| Municipal building, Camiling | 9,000 | | | | 9,000 |
| Total | 60,750 | 63,300 | 112,700 | 60,000 | 296,750 |

These loans are repayable as shown under.

### ALBAY.

For the purpose of continuing the construction of trails in the subprovince of Catanduanes, a loan of ₱15,000 is hereby granted the Province of Albay, payable quarterly, at the rate of 4 per cent per annum. This loan will be made from the insurance fund created by Act No. 1728. The payment, including interest due, when collected, will be credited as follows:

| Payment. | Act No. 1728. | |
|---|---|---|
| | Principal. | Interest. |
| 1914 | ₱15,000.00 | ₱600.00 |

### AMBOS CAMARINES.

Subject to the conditions contained in Resolution No. 108, series of 1913, of the municipality of Iriga and the letters of the Governor-General, dated March 11, 1913, May 14, 1913, and May 19, 1913, respectively, a loan of ₱7,500 is hereby granted the municipality of Iriga payable in five equal annual installments due in six, seven, eight, nine, and ten years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that on the direction of the Executive Secretary, acting for and in behalf of the municipal board, the said amount be placed for disbursement to the credit of the provincial treasurer of Ambos Camarines, who should be advised accordingly. This loan will be made from the city of Manila sewer and waterworks bonds sinking fund created by Act No. 1323 of the Philippine Commission. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1323. | |
|---|---|---|
| | Principal. | Interest. |
| First | | ₱300.00 |
| Second | | 300.00 |
| Third | | 300.00 |
| Fourth | | 300.00 |
| Fifth | | 300.00 |
| Sixth | ₱1,500.00 | 300.00 |
| Seventh | 1,500.00 | 240.00 |
| Eighth | 1,500.00 | 180.00 |
| Ninth | 1,500.00 | 120.00 |
| Tenth | 1,500.00 | 60.00 |

### BATANGAS.

For the purpose of erecting a municipal building a loan of ₱9,000 is hereby granted the municipality of Lemery, Province of Batangas, repayable in three equal annual installments due in one, two, and three years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that the said amount be placed for disbursement to the credit of the provincial treasurer of Batangas, who should be advised accordingly. Six thousand pesos of this loan will be made from the insurance fund created by Act No. 1728, and ₱3,000 from the public works bonds sinking fund created by Act No. 1729. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1728. | | Act No. 1729. | |
|---|---|---|---|---|
| | Principal. | Interest. | Principal. | Interest. |
| First | ₱3,000.00 | ₱240.00 | | ₱120.00 |
| Second | 3,000.00 | 120.00 | | 120.00 |
| Third | | | ₱3,000.00 | 120.00 |

For the purpose of purchasing an additional market site and erecting modern market buildings, a loan of ₱15,000 is hereby granted the municipality of Taal, Province of Batangas, payable in five equal annual installments due in one, two, three, four, and five years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that the said amount be placed for disbursement to the credit of the provincial treasurer of Batangas, who should be advised accordingly. Six thousand pesos of this loan will be made from the insurance fund created by Act No. 1728, and ₱9,000 from the public works bonds sinking fund created by Act No. 1729. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1728. | | Act No. 1729. | |
|---|---|---|---|---|
| | Principal. | Interest. | Principal. | Interest. |
| First | ₱3,000.00 | ₱240.00 | | ₱360.00 |
| Second | 3,000.00 | 120.00 | | 360.00 |
| Third | | | ₱3,000.00 | 360.00 |
| Fourth | | | 3,000.00 | 240.00 |
| Fifth | | | 3,000.00 | 120.00 |

### BOHOL.

Subject to the conditions contained in Resolution No. 128, series of 1913, of said municipality of Loboc and the letters of the Governor-General, dated March 11, 1913, May 14, 1913, and May 19, 1913, respectively, a loan of ₱6,250 is hereby granted the municipality of Loboc payable in five equal annual installments due in six, seven, eight, nine, and ten years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that on direction of the Executive Secretary, acting for and in behalf of the municipal board, the said amount be placed for disbursement to the credit of the provincial treasurer of Bohol, who should be advised accordingly. This loan will be made from the city of Manila sewer and waterworks bonds sinking fund created by Act No. 1323 of the Philippine Commission. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1323. | |
|---|---|---|
| | Principal. | Interest. |
| First | | ₱250.00 |
| Second | | 250.00 |
| Third | | 250.00 |
| Fourth | | 250.00 |
| Fifth | | 250.00 |
| Sixth | ₱1,250.00 | 250.00 |
| Seventh | 1,250.00 | 200.00 |
| Eighth | 1,250.00 | 150.00 |
| Ninth | 1,250.00 | 100.00 |
| Tenth | 1,250.00 | 50.00 |

### CITY OF BAGUIO.

I have the honor to state that, for the purpose of purchasing the Baguio electric-lighting plant and making any and all improvements thereof, a loan of ₱60,000 is hereby granted the city of Baguio, Benguet, payable in ten equal annual installments due in one, two, three, four, five, six, seven, eight, nine, and ten years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 3 per cent per annum, and to request that the said amount be placed for disbursement to the credit of the city treasurer thereof who should be advised accordingly. This loan will be made from the gold standard fund created by Act No. 2083.

### CAPIZ.

For the purpose of erecting a provincial building, a loan of ₱55,000 is hereby granted the Province of Capiz, payable in seven installments, as follows, together with interest, payable quarterly, at the rate of 4 per cent per annum:

| | |
|---|---|
| Dec. 23, 1911 | ₱11,000.00 |
| Dec. 23, 1912 | 5,500.00 |
| June 23, 1913 | 5,500.00 |
| Dec. 23, 1913 | 5,500.00 |
| Dec. 23, 1914 | 11,000.00 |
| Dec. 23, 1915 | 11,000.00 |
| Dec. 23, 1916 | 5,500.00 |

It is requested that the said amount be placed for disbursement to the credit of the provincial treasurer of Capiz, who should be advised accordingly. Sixteen thousand five hundred pesos of this loan will be made from the insurance fund created by Act No. 1728, and ₱38,500 will be made from the sinking fund created by Act No. 1729. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1728. | | Act No. 1729. | |
|---|---|---|---|---|
| | Principal. | Interest. | Principal. | Interest. |
| Dec. 23, 1911 | ₱11,000.00 | ₱660.00 | | ₱1,320.00 |
| Dec. 23, 1912 | 5,500.00 | 440.00 | | 1,320.00 |
| June 23, 1913 | | | ₱5,500.00 | 110.00 |
| Dec. 23, 1913 | | | 5,500.00 | 1,320.00 |
| Dec. 23, 1914 | | | 11,000.00 | 1,100.00 |
| Dec. 23, 1915 | | | 11,000.00 | 660.00 |
| Dec. 23, 1916 | | | 5,500.00 | 220.00 |

### ILOCOS NORTE.

Subject to the conditions contained in Resolution No. 255, series of 1913, of said municipality of Batac and the letters of the Governor-General, dated March 11, 1913, May 14, 1913, and May 19, 1913, respectively, the insular treasurer is hereby authorized and directed to transfer to the Insular Government public works bonds (first series) now held as an investment of the city of Manila sewer and waterworks bonds sinking fund, to the par value of ₱7,000; and from the proceeds thus secured, and uninvested money in said fund, a loan of ₱11,000 is hereby granted the municipality of Batac payable in five equal annual installments due in six, seven, eight, nine, and ten years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that on direction of the Executive Secretary, acting for and in behalf of the municipal board, the said amount be placed for disbursement to the credit of the provincial treasurer of Ilocos Norte, who should be advised accordingly. This loan will be made from the city of Manila sewer and waterworks bonds sinking fund created by Act No. 1323 of the Philippine Commission. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1323. | |
|---|---|---|
| | Principal. | Interest. |
| First | | ₱440.00 |
| Second | | 440.00 |
| Third | | 440.00 |
| Fourth | | 440.00 |
| Fifth | | 440.00 |
| Sixth | ₱2,200 | 440.00 |
| Seventh | 2,200 | 352.00 |
| Eighth | 2,200 | 264.00 |
| Ninth | 2,200 | 176.00 |
| Tenth | 2,200 | 88.00 |

For the purpose of purchasing a market site and erecting modern market buildings, a loan of ₱11,000 is hereby granted the municipality of Batac, Ilocos Norte, payable in five equal annual installments due in one, two, three, four, and five years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that the said amount be placed for disbursement to the credit of the provincial treasurer of Ilocos Norte, who should be advised accordingly. Four thousand four hundred pesos of this loan will be made from the insurance fund created by Act No. 1728, and ₱6,600 from the public works bonds sinking fund created by Act No. 1729. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1728. | | Act No. 1729. | |
|---|---|---|---|---|
| | Principal. | Interest. | Principal. | Interest. |
| First | ₱2,200.00 | ₱176.00 | | ₱264.00 |
| Second | 2,200.00 | 88.00 | | 264.00 |
| Third | | | ₱2,200.00 | 264.00 |
| Fourth | | | 2,200.00 | 176.00 |
| Fifth | | | 2,200.00 | 88.00 |

### ILOILO.

For the purpose of erecting a central school building, a loan of ₱12,500 is hereby granted the municipality of Iloilo, Province of Iloilo, payable in five annual installments due in one, two, three, four, and five years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. This loan will be made from the public works bonds sinking fund created by Act No. 1729. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1729. | |
|---|---|---|
| | Principal. | Interest. |
| First | ₱2,500.00 | ₱500.00 |
| Second | 2,500.00 | 400.00 |
| Third | 2,500.00 | 300.00 |
| Fourth | 2,500.00 | 200.00 |
| Fifth | 2,500.00 | 100.00 |

### LA UNION.

Subject to the conditions contained in Resolution No. 119, series of 1913, of said municipality of Naguilian and the letters of the Governor-General, dated March 11, 1913, May 14, 1913, and May 19, 1913, respectively, a loan of ₱8,000 is hereby granted the municipality of Naguilian payable in five equal annual installments due in six, seven, eight, nine, and ten years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that on direction of the Executive Secretary, acting for and in behalf of the municipal board, the said amount be placed for disbursement to the credit of the provincial treasurer of La Union, who should be advised accordingly. This loan will be made from the city of Manila sewer and waterworks bonds sinking fund created by Act No. 1323 of the Philippine Commission. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1323. | |
|---|---|---|
| | Principal. | Interest. |
| First | | ₱320.00 |
| Second | | 320.00 |
| Third | | 320.00 |
| Fourth | | 320.00 |
| Fifth | | 320.00 |
| Sixth | ₱1,600.00 | 320.00 |
| Seventh | 1,600.00 | 256.00 |
| Eighth | 1,600.00 | 192.00 |
| Ninth | 1,600.00 | 128.00 |
| Tenth | 1,600.00 | 64.00 |

### LEYTE.

Subject to the conditions contained in Resolution No. 156, series of 1913, of said municipality of Baybay and the letters of the Governor-General, dated March 11, 1913, May 14, 1913, and May 19, 1913, respectively, a loan of ₱10,000 is hereby granted the municipality of Baybay payable in five equal annual installments due in six, seven, eight, nine and ten years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that on direction of the Executive Secretary, acting for and in behalf of the municipal board, the said amount be placed for disbursement to the credit of the provincial treasurer of Leyte, who should be advised accordingly. This loan will be made from the city of Manila sewer and waterworks bonds sinking fund, created by Act No. 1323 of the Philippine Commission. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1323. | |
|---|---|---|
| | Principal. | Interest. |
| First | | ₱400.00 |
| Second | | 400.00 |
| Third | | 400.00 |
| Fourth | | 400.00 |
| Fifth | | 400.00 |
| Sixth | ₱2,000.00 | 400.00 |
| Seventh | 2,000.00 | 320.00 |
| Eighth | 2,000.00 | 240.00 |
| Ninth | 2,000.00 | 160.00 |
| Tenth | 2,000.00 | 80.00 |

For the purpose of purchasing an additional market site, remodeling the present market building, and constructing additional modern market buildings, a loan of ₱12,500 is hereby granted the municipality of Tacloban, Province of Leyte, payable in five annual installments due in one, two, three, four, and five years from the date of the loan, as follows, together with interest, payable quarterly, at the rate of 4 per cent per annum: First year, ₱2,000; second year, ₱2,500; third year, ₱2,500; fourth year, ₱2,500; and fifth year, ₱3,000. It is requested that the said amount be placed for disbursement to the credit of the provincial treasurer of Leyte, who should be advised accordingly. This will be made from the public works bonds sinking fund created by Act No. 1729. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1729. | |
|---|---|---|
| | Principal. | Interest. |
| First | ₱2,000.00 | ₱500.00 |
| Second | 2,500.00 | 420.00 |
| Third | 2,500.00 | 320.00 |
| Fourth | 2,500.00 | 220.00 |
| Fifth | 3,000.00 | 120.00 |

### OCCIDENTAL NEGROS.

For the purpose of purchasing a market site and erecting modern market buildings, a loan of ₱9,000 is hereby granted the municipality of San Carlos, Province of Occidental Negros, payable in five equal annual installments due in one, two, three, four, and five years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that the said amount be placed for disbursement to the credit of the provincial treasurer of Occidental Negros, who should be advised accordingly. This loan will be made from the public works bonds sinking fund created by Act No. 1729. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1729. | |
|---|---|---|
| | Principal. | Interest. |
| First | ₱1,800.00 | ₱360.00 |
| Second | 1,800.00 | 288.00 |
| Third | 1,800.00 | 216.00 |
| Fourth | 1,800.00 | 144.00 |
| Fifth | 1,800.00 | 72.00 |

### ORIENTAL NEGROS.

For the purpose of purchasing a market site and erecting modern market buildings, a loan of ₱6,000 is hereby granted the municipality of Bais, Oriental Negros, payable in five equal annual installments due in one, two, three, four, and five years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that the said amount be placed for disbursement to the credit of the provincial treasurer of Oriental Negros, who should be advised accordingly. Two thousand four hundred pesos of this loan will be made from the insurance fund created by Act No. 1728, and ₱3,600 from the public works bonds sinking fund created by Act No. 1729. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1728. | | Act No. 1729. | |
|---|---|---|---|---|
| | Principal. | Interest. | Principal. | Interest. |
| First | ₱1,200.00 | ₱96.00 | | ₱144.00 |
| Second | 1,200.00 | 48.00 | | 144.00 |
| Third | | | ₱1,200.00 | 144.00 |
| Fourth | | | 1,200.00 | 96.00 |
| Fifth | | | 1,200.00 | 48.00 |

For the purpose of purchasing a market site and erecting modern market buildings, a loan of ₱11,000 is hereby granted the municipality of Dumaguete, Province of Oriental Negros, payable in five equal annual instalments due in one, two, three, four, and five years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that the said amount be placed for disbursement to the credit of the provincial treasurer of Oriental Negros, who should be advised accordingly. Four thousand four hundred pesos of this loan will be made from the insurance fund created by Act No. 1728, and ₱6,600 from the public works bonds sinking fund created by Act No. 1729. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1728. | | Act No. 1729. | |
|---|---|---|---|---|
| | Principal. | Interest. | Principal. | Interest. |
| First | ₱2,200.00 | ₱176.00 | | ₱264.00 |
| Second | 2,200.00 | 88.00 | | 264.00 |
| Third | | | ₱2,200.00 | 264.00 |
| Fourth | | | 2,200.00 | 176.00 |
| Fifth | | | 2,200.00 | 88.00 |

### PAMPANGA.

For the purpose of boring an artesian well, a loan of ₱1,000 is hereby granted the municipality of Mabalacat, Province of Pampanga, payable in five equal annual installments due in one, two, three, four, and five years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that the said amount be placed for disbursement to the credit of the provincial treasurer of Pampanga, who should be advised accordingly. This loan will be made from the public works bonds sinking fund created by Act No. 1729. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1729. | |
|---|---|---|
| | Principal. | Interest. |
| First | ₱200.00 | ₱40.00 |
| Second | 200.00 | 32.00 |
| Third | 200.00 | 24.00 |
| Fourth | 200.00 | 16.00 |
| Fifth | 200.00 | 8.00 |

### PANGASINAN.

For the purpose of erecting a modern municipal building, a loan of ₱10,000 is hereby granted the municipality of Urdaneta, Province of Pangasinan, payable in four equal annual installments due in one, two, three, and four years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that the said amount be placed for disbursement to the credit of the provincial treasurer of Pangasinan, who should be advised accordingly. Five thousand pesos of this loan will be made from the insurance fund created by Act No. 1728, and ₱5,000 from the public works bonds sinking fund created by Act No. 1729. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1728. | | Act No. 1729. | |
|---|---|---|---|---|
| | Principal. | Interest. | Principal. | Interest. |
| First | ₱2,500.00 | ₱200.00 | | ₱200.00 |
| Second | 2,500.00 | 100.00 | | 200.00 |
| Third | | | ₱2,500.00 | 200.00 |
| Fourth | | | 2,500.00 | 100.00 |

### TARLAC.

Subject to the condition contained in Resolution No. 123, series of 1913, of said municipality of Victoria and the letters of the Governor-General, dated March 11, 1913, May 14, 1913, and May 19, 1913, respectively, a loan of ₱9,000 is hereby granted the municipality of Victoria payable in five equal annual installments due in six, seven, eight, nine, and ten years respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that on direction of the Executive Secretary, acting for and in behalf of the municipal board, the said amount be placed for disbursement to the credit of the provincial treasurer of Tarlac, who should be advised accordingly. This loan will be made from the city of Manila sewer and waterworks bonds sinking fund created by Act No. 1323 of the Philippine Commission. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1323. | |
|---|---|---|
| | Principal. | Interest. |
| First | | ₱360.00 |
| Second | | 360.00 |
| Third | | 360.00 |
| Fourth | | 360.00 |
| Fifth | | 360.00 |
| Sixth | ₱1,800.00 | 360.00 |
| Seventh | 1,800.00 | 288.00 |
| Eighth | 1,800.00 | 216.00 |
| Ninth | 1,800.00 | 144.00 |
| Tenth | 1,800.00 | 72.00 |

Subject to the conditions contained in Resolution No. 198, series of 1913, of said municipality of Camiling, and the letters of the Governor-General, dated March 11, 1913, May 14, 1913, and May 19, 1913, respectively, a loan of ₱9,000 is hereby granted the municipality of Camiling payable in four equal annual installments due in five, six, seven, and eight years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that on direction of the Executive Secretary, acting for and in behalf of the municipal board, the said amount be placed for disbursement to the credit of the provincial treasurer of Tarlac, who should be advised accordingly. This loan will be made from the city of Manila sewer and waterworks bonds sinking fund created by Act No. 1323 of the Philippine Commission. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1323. | |
|---|---|---|
| | Principal. | Interest. |
| First | | ₱360.00 |
| Second | | 360.00 |
| Third | | 360.00 |
| Fourth | | 360.00 |
| Fifth | ₱2,250.00 | 360.00 |
| Sixth | 2,250.00 | 270.00 |
| Seventh | 2,250.00 | 180.00 |
| Eighth | 2,250.00 | 90.00 |

For the purpose of purchasing a market site and erecting modern market buildings, a loan of ₱9,000 is hereby granted the municipality of Victoria, Province of Tarlac, payable in five equal annual installments due in one, two, three, four, and five years, respectively, from the date of the loan, together with interest, payable quarterly, at the rate of 4 per cent per annum. It is requested that the said amount be placed for disbursement to the credit of the provincial treasurer of Tarlac, who should be advised accordingly. Three thousand six hundred pesos of this loan will be made from the insurance fund created by Act No. 1728, and ₱5,400 from the public works bonds sinking fund created by Act No. 1729. The annual payments, including interest due, when collected, will be credited as follows:

| Payments. | Act No. 1728. | | Act No. 1729. | |
|---|---|---|---|---|
| | Principal. | Interest. | Principal. | Interest. |
| First | ₱1,800.00 | ₱144.00 | | ₱216.00 |
| Second | 1,800.00 | 72.00 | | 216.00 |
| Third | | | ₱1,800.00 | 216.00 |
| Fourth | | | 1,800.00 | 144.00 |
| Fifth | | | 1,800.00 | 72.00 |

## THE KILLJOY.

Oh, the pessimistic prowler is a most incessant scowler and a hooter and a howler, on occasions small or great.

He will revel in invective. With pretensions all corrective, but with reasoning defective, he'll discuss affairs of state.

He will frame up a prediction of disaster and affliction and defy all contradiction that might cheer him up a bit.

He's our leading joy-forsaker. He's our foremost trouble-maker, and with him the undertaker is the man that makes a hit.

He would hunt a yellowjacket: to its lair he'd surely track it. He would buffet it and whack it, till it simply had to sting.

For, whatever he is doing there is trouble still renewing and a hard luck story brewing as the burden of his song.

He is gloom's most trusty warder, chasing pleasure from our border, and he thinks life's out of order if it isn't going wrong.

—*Washington Star.*

Lukban, Tayabas Province.

Church Plaza, Lukban, Tayabas Province.

# APPENDIX C.

## PROJECTS ACTIVE OCTOBER 1, 1913.

| Provinces. | Roads. | | | | Bridges and culverts. | | | | Provincial administration buildings. | | | Municipal administration buildings. | | Prisons. | | Schools. | | | | Construction and operation. | | | | | | | | | Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Construction. | Maintenance. | Repair. | Reconstruction. | Construction. | Maintenance. | Repair. | Reconstruction. | Construction. | Maintenance. | Repair and alteration. | Construction. | Reconstruction. | Construction. | Repair and alteration. | Construction. | Maintenance. | Repair and alteration. | Reconstruction. | Markets. | Parks, grounds, and athletic fields. | Miscellaneous buildings. | Ferries. | Water systems. | Record vaults. | Quarries. | Telephone lines. | Electric light plant. | Miscellaneous. | |
| Albay | 2 | 2 | | 1 | 3 | 2 | | 1 | | 1 | | | | | | 2 | 1 | | | 4 | 1 | | | | | | | | 3 | 23 |
| Ambos Camarines | 2 | 9 | | 2 | 5 | 1 | | | | | | | | | | | | | | | 1 | | | | | | | | 1 | 21 |
| Antique | 3 | 2 | | 1 | 2 | | | | | 1 | | | | | | 2 | 1 | | | | | | | | | | | | 1 | 13 |
| Bataan | 1 | 2 | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | 1 | 6 |
| Batangas | 4 | 4 | | | 2 | 1 | | | | 2 | | 1 | | | 1 | 2 | 3 | | | 2 | 3 | 2 | | | | | | | 7 | 34 |
| Bohol | | 3 | 1 | 1 | 6 | | | | | | | | | | | 3 | | | 1 | 2 | | 1 | | 2 | | | | | 1 | 21 |
| Bulacan | 4 | 3 | | | 7 | | | | | | | | | | | 3 | | | | 1 | | | | | | | | | 1 | 19 |
| Cagayan | 2 | 4 | | | 2 | 1 | | | | 1 | | | | | 1 | 1 | 1 | | | | | | | | | | | | 4 | 17 |
| Capiz | 3 | 2 | | 3 | 1 | | | | | | | | | | | 1 | | | 1 | | 2 | 1 | 1 | | | | | | | 15 |
| Cavite | 4 | 2 | | | 1 | | | | | | | | | | | 6 | | | | | | | | | | | | | | 13 |
| Cebu | 7 | 2 | | | | 1 | | | | | | | | 1 | | 3 | | | | 6 | | 1 | | 2 | | | | | 1 | 24 |
| Ilocos Norte | 3 | 2 | | | 3 | | | 1 | | | 1 | | | | | 9 | | 2 | | | | | | | | | | | | 2 | 23 |
| Ilocos Sur | 5 | 3 | 1 | | 2 | 1 | | | | | | | 2 | | | 10 | | | | | | | 2 | 1 | | | | | | 3 | 30 |
| Iloilo | 3 | 3 | 1 | 1 | 2 | | | | | | | | | | | | | | | 3 | | | | 1 | | 1 | | | 1 | 16 |
| Isabela | 2 | 2 | | | 3 | | | | | | | | | | | 1 | | | | | 1 | | 1 | | | | | | | 10 |
| Laguna | 4 | 3 | 5 | 1 | 1 | | | 1 | | | | | | | | 9 | | | | 3 | | | | | | 1 | 2 | | 3 | 33 |
| La Union | 4 | 4 | | | 5 | | | | | | | | | | | 5 | | | | 1 | 1 | | 1 | | | | | | 2 | 23 |
| Leyte | 2 | 1 | | | 9 | 1 | | | 1 | 1 | | | | | | 8 | | | | | | | 1 | | | | | | | 24 |
| Misamis | 4 | 3 | | 1 | 5 | | | | | | | | | | | 2 | | | | | | | | | | | | 1 | | 16 |
| Nueva Ecija | | 3 | | | 3 | | | | | | | | | | | 7 | | | | 1 | 1 | | 1 | 1 | | | | | 1 | 18 |
| Occidental Negros | 5 | 2 | | 5 | 1 | | | 1 | | | | | | | | 1 | | | | 2 | | | 1 | | | | | | 1 | 19 |
| Oriental Negros | 2 | 4 | | | 1 | | | | 1 | | | | | | | 5 | | | | | | | | | | | | | 2 | 15 |
| Pampanga | 1 | 3 | | | 1 | | | | | | | | | | 1 | 1 | | | | 2 | | | | | | | 1 | | 2 | 12 |
| Pangasinan | 3 | 3 | | 3 | 5 | | | | | | | 2 | 1 | | | 9 | | 1 | 2 | 7 | 3 | | 2 | 2 | | | | | 8 | 51 |
| Rizal | 8 | 13 | | 2 | | | | 1 | | | | | | | | | | | | | | | | | | | | | 2 | 26 |
| Samar | 3 | 2 | | | | | | | | | | | | | | 2 | | | | | | | | | | | | | 3 | 10 |
| Sorsogon | 3 | 2 | | | 3 | | | | | | | | | | | 2 | | | | | | | | | | | | | 5 | 15 |
| Surigao | 2 | 2 | | | | | | | | | | | | | | 4 | | 3 | | | | | | | | | | | | 11 |
| Tarlac | 1 | 3 | | | 4 | | | | | | | | | | | 1 | | | | 2 | | | | | | | | | 2 | 13 |
| Tayabas | 4 | 3 | | | 2 | | | | | 1 | | | | | | 2 | | 1 | | | 1 | | | 2 | | | | | | 16 |
| Zambales | | 1 | | | 5 | | | | | 2 | | | | | | | | | | | | | | 1 | | | | | 2 | 11 |
| Total | 91 | 97 | 8 | 21 | 86 | 8 | | 5 | 2 | 9 | 1 | 3 | 3 | 1 | 3 | 101 | 6 | 7 | 4 | 36 | 14 | 5 | 10 | 12 | | 2 | 3 | 1 | 59 | 598 |

The 59 projects shown under the caption "Miscellaneous" represent 22 surveys and investigations of roads, bridges, rivers, etc., 4 dikes, 2 river controls, 2 fence constructions, 1 bituminous road, 1 irrigation system, etc.

# BUREAU OF PUBLIC WORKS

## ORGANIZATION

WARWICK GREENE, *Director*
C. LINDSEY, *Assistant to the Director*
C. W. HUBBELL, *Chief Engineer*
W. L. GORTON, *Chief Irrigation Engineer*
C. W. KEITH, *Chief, Division of Engineering Design*
J. MCGREGOR, *Structural Engineer, Chief Building Division*
L. L. COOK, *Superintendent Automobile Division, Manila*
J. L. VICKERS, *Superintendent Artesian Wells Division*
MAX DOBBINS, *Statistical Engineer*
WILLIAM HIRZEL, *Acting Chief Accountant*
O. K. OLSON, *Property Clerk*
H. M. JOHNSTON, *In charge of Record Division*
A. K. JONES, *Law Clerk*
MRS. R. D. BENDER, *In charge of Library*

## PROVINCIAL DIVISION

E. J. WESTERHOUSE, *Chief Division Engineer*

### DIVISION ENGINEERS

FIRST DIVISION ..... D. E. HENRY

PROVINCES

| | | |
|---|---|---|
| Cagayan | Ilocos Sur | Nueva Ecija |
| Isabela | Zambales | Pangasinan |
| Ilocos Norte | La Union | Tarlac |

THIRD DIVISION ..... W. H. WAUGH

PROVINCES

| | | |
|---|---|---|
| Antique | Cebu | Oriental Negros |
| Bohol | Iloilo | |
| Capiz | Occidental Negros | |

SECOND DIVISION ..... C. E. GORDON

PROVINCES

| | | |
|---|---|---|
| Bataan | Cavite | Rizal |
| Batangas | Laguna | Tayabas |
| Bulacan | Pampanga | |

FOURTH DIVISION ..... B. VON SCHMELING

PROVINCES

| | | |
|---|---|---|
| Albay | Misamis | Sorsogon |
| Ambos Camarines | Samar | |
| Leyte | Surigao | |

H. F. CAMERON, *Division Engineer.*
(On special duty, Provincial Division.)

### DISTRICT ENGINEERS

| | |
|---|---|
| Barry, R. L. | Tuguegarao, Cagayan |
| Baluyot, Sotero | Ilagan, Isabela |
| Root, W. F. | Laoag, Ilocos Norte |
| Smith, E. D. | Vigan, Ilocos Sur |
| McComb, D. Q. | San Fernando, La Union |
| Austin, A. W. | Cabanatuan, Nueva Ecija |
| Morrison, C. G. | Lingayen, Pangasinan |
| Brown, E. C. | Tarlac, Tarlac |
| Kasilag, Marcial | San Narciso, Zambales |
| Vallarta, Julian | Balañga, Bataan |
| Caton, J. H. 3rd | Batangas, Batangas |
| Harrison, J. L. | Malolos, Bulacan |
| Bennett, C. R. | Cavite, Cavite |
| Barry, J. R | Los Baños, Laguna |
| Beckjord, J. G. | San Fernando, Pampanga |
| Schenk, E. E. | Pasig, Rizal |
| Miles, H. V. | Lucena, Tayabas |
| Agcaoili, Romarico | San Jose, Antique |
| Boggess, L. S. | Tagbilaran, Bohol |
| Scheidemantel, L. W. | Capiz, Capiz |
| Russell, Claud | Cebu, Cebu |
| Glenn, R. V. | Iloilo, Iloilo |
| Sylvester, A. T. | Bacolod, Occidental Negros |
| Grosvenor, I. R. | Dumaguete, Orient. Negros |
| Marshall, J. T. | Albay, Albay |
| Dandois, Chas. S. | Nueva Caceres, Ambos Camarines |
| Clark, L. T. | Tacloban, Leyte |
| Allen, R. N. | Cagayan, Misamis |
| Cookingham, J. C. | Catbalogan, Samar |
| Meehleib, H. R. | Surigao, Surigao |
| Lilley, H. B. | Sorsogon, Sorsogon |